#### Evaluation and Analysis of Environmental Performance and Benefit of Environmentally-Advantaged Aircraft Deicing Fluids

Development of the Decision Support Methodology and Case Studies

Prepared for: SAIC

April 2008



#### REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

The public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing the burden, to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.

subject to any pena	ty for failing to comp	ly with a collection o	f information if it does not displa HE ABOVE ADDRESS.	y a currently valid (	OMB contro	l number.
	TE (DD-MM-YY		ORT TYPE			3. DATES COVERED (From - To)
04	-18-2008		Final Repo	ort		Sept 2004 - Apr 2008
4. TITLE AND	SUBTITLE	•			5a. CO	NTRACT NUMBER
Demonstration	n/Validation of	Environmental	lly Advantaged			4400099353
			Propylene Glycol		5b. GR	ANT NUMBER
	mnoTech, Inc.					
			Performance and Benef	fit of		
	lly-Advantaged			l:	5c.PR	OGRAM ELEMENT NUMBER
Development	of the Decision	Support Mem	odology and Case Stud	iles		
6. AUTHOR(S)	1				5d. PR	OJECT NUMBER
Dean Mericas	Tad Slawecki	Peter Klaver,	David Dilks, Christoph	ner Cieciek		
			, 1		50 TA	SK NUMBER
					Je. IA	OK WOWIDEN
					5f. WO	ORK UNIT NUMBER
7. PERFORMIN	IG ORGANIZATI	ON NAME(S) AI	ND ADDRESS(ES)		<u> </u>	8. PERFORMING ORGANIZATION
LimnoTech		CH2M				REPORT NUMBER
501 Avis Driv	e Suite 1		Research Blvd., Build	ing 4 Suite 2	50	FMI Report No. SAI-050053-1851
Ann Arbor, M			n, TX 78759			-
,			,			
9. SPONSORI	IG/MONITORING	G AGENCY NAM	IE(S) AND ADDRESS(ES)			10. SPONSOR/MONITOR'S ACRONYM(S)
Science Appli	cations Internat	ional Corporat	ion			
11251 Roger I		1				
Reston, VA 20	190					11. SPONSOR/MONITOR'S REPORT
						NUMBER(S)
12. DISTRIBUT	ION/AVAILABIL	ITY STATEMEN	Т			
Distribution U	nlimited					
12 CLIDDLEME	NTARY NOTES					
13. SUPPLEIVE	NIAKT NOTES					
14. ABSTRACT	-					
		a Duniant Tann	af Limma Taah and Cl	HOM IIII 1	orval a m a d	l and demonstrated a tool for airfield
						and demonstrated a tool for an held aircraft deicing fluid (ADF) with
						n determining if a newly developed ADF
						ce, and compliance costs.
						nvironmental managers at U.S.
						of benefits that could be realized by
				n alternative f	luid, and	12. Application of the Decision Support Tool
in a series of c	ase studies to p	rovide real-wo	rld examples.			
15. SUBJECT	TERMS					
aircraft deicing	g fluids, decisio	n support tool,	BOD5, environmental	benefit, and	propyler	ne glycol
`	•					
				1		
	CLASSIFICATIO		17. LIMITATION OF ABSTRACT	18. NUMBER OF		ME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	C. THIS PAGE		PAGES	Dean M	
U	U	U	UU	44	19b. TEI	LEPHONE NUMBER (Include area code)
			ĺ	I ''	I	(512) 453-2468

This page is blank to facilitate double sided printing.

#### **TABLE OF CONTENTS**

3
3
7
7
7
10
13
17
19

#### **LIST OF FIGURES**

Figure 1. Evaluation Worksheet for Alternative Deicer Fluids	4
Figure 2. Pittsburgh ANG Evaluation	
Figure 3. Bangor ANG Evaluation	
Figure 4. PDX Evaluation	14
LIST OF TABLES	
Table 1. PDX Airfield Model Results	16

#### **LIST OF ATTACHMENTS**

Attachment 1. Decision Support Tool User Instructions

Attachment 2. Additional Figures

#### 1. INTRODUCTION

At the direction of ESTCP, the Project Team of LimnoTech and CH2M HILL has developed and demonstrated a tool for airfield environmental managers to use in evaluating the potential environmental benefits of an aircraft deicing fluid (ADF) with different environmental properties than currently used products. The specific interest is in determining if a newly developed ADF represents significant advantages in terms of environmental impact, regulatory compliance, and compliance costs.

#### The work consisted of two efforts:

- 1. The development of a Decision Support Tool for environmental managers at U.S. Air Force and Air National Guard facilities to allow for the semi-quantitative evaluation of benefits that could be realized by switching from a propylene glycol-based aircraft deicing fluid to an alternative fluid, and
- 2. Application of the Decision Support Tool in a series of case studies to provide real-world examples.

Sections 2 and 3 of this document contain descriptions of the Decision Support Tool development and the Case Studies, respectively.

This page is blank to facilitate double sided printing.

#### 2. DECISION SUPPORT TOOL DEVELOPMENT

The development of the Decision Support Tool was accomplished through the collaborative identification of factors important in supporting the analysis of changing the type of ADF used at a facility. The tool was implemented as a Microsoft Excel® workbook to provide a familiar interface and ensure wide access to the tool's analytical capabilities. A series of progressively refined versions of the tool were developed and tested by the project team, resulting in the final version that is shown in Figure 1.

The "Evaluation Worksheet for Alternative Aircraft Deicers" gives environmental managers a tool with which to perform a semi-quantitative screening-level assessment of likely environmental and regulatory compliance implications resulting from a change in ADF used at their facility. The user specifies current deicing fluid usage, collection, discharge, and disposal information. The spreadsheet performs a series of calculations and provides feedback to the user describing the potential changes in compliance achievement and operational costs that may result from a change in ADF usage.

Several areas of possible environmental and operational benefits are considered in the support tool:

- Aquatic toxicity. The tool compares reported aquatic toxicities for the current and proposed ADFs and advises on likely reductions of potential toxic effects from fugitive emissions and discharges.
- **Permit compliance**. The tool uses permit and monitoring information together with ADF characteristics to evaluate possible improvements in compliance with mass or concentration limits in discharge permits.
- Oxygen depletion in receiving waters. In situations where deicing fluid reaches a stream or river, the tool can use ADF characteristics together with information about stream flow, temperature, and other parameters to estimate possible reductions in impacts of dissolved oxygen in the stream.
- Treatment costs and efficiency. The tool uses ADF characteristics together with treatment capacity and cost information provided by the user to estimate potential cost savings and increase in storage availability from use of an alternative ADF.
- **Product costs.** The cost implications of switching to the alternative fluid are estimated in terms of change in average annual expenditures.

Instructions are provided to guide the user through the data input process. The instructions include a description of each input to the tool and guidance on identifying the appropriate data or information required for each field. A copy of the instructions is included as Attachment 1.

his evaluation tool was designed to assist a Base Environmental Manager (EM) in assessing the	e likely environmental, regulatory
ompliance, and cost implications of a new Type I ADF formulation that is being considered as an	
n use. The evaluation is at a screening level, intended to give the EM a sound indication of the ge	
hanges and benefits that can be expected with a switch to the alternative ADF. This information is	-
egarding a switch to the new formulation.	a mondod to support debicions
is essential to understand that the tool is not intended to replace more sophisticated analyses th	
lemonstrations of regulatory compliance or engineering design of deicing runoff management sy	/stems.
ITE INFORMATION	
Name	
ódress	
erson filling out form	
-mail Address	Telephone Number
EURRENT SITUATION	
IPDES Storm Water Permit Information	
1 Does your site have an NPDES Storm Water permit for discharge of deicing runoff?	1 YES NO
2 NPDES permit number	2
3 Permitting authority	3
Permit limits during periods of peak deicing activity	BOD5 COD
4 Most stringent permitted discharge concentration (mg/L). Leave blank if there are no limits.	4
5 Most stringent permitted maximum daily load (lbs/day). Leave blank if there are no limits.	5
Current Type I Deicer Information (See MSDS and manufacturer's literature)	Type I
6 Decay rate at 20°C (1/day)	6 0.18
7 BOD5 concentration of propylene glycol (mg/L)	7 650,000
8 Percent glycol in purchased product	8
9 BOD5 concentration in the purchased product (mg/L)	9 0
96-hour aquatic toxicity (LC50) for fathead minnows (mg/L)	10
1 48-hour aquatic toxicity (LC50) for daphnia (mg/L)	11
2 Aquatic toxicity (LC50) for other organisms (mg/L)	12
3 Name of other test organism	13
4 Annual volume of applied aircraft deicer mixture (gallons at working concentration)	14
5 Maximum daily volume of applied aircraft deicer mixture (gallons at working concentration)	15
6 Typical application strength of purchased deicer (100% = no dilution of purchased product)	16
7 Calculated annual volume of aircraft deicer at purchased concentration (gallons)	17 0
8 Cost of aircraft deicer at purchased concentration (\$/gallon)	18
eicer Collection and Storage	
5	19 YES NO
	20 Other (0% - 100%)
· · · · · · · · · · · · · · · · · · ·	21 0%
	22 30%
reatment Information	Flow BOD5 COD
3 Maximum daily amount accepted for treatment	23
4 Units	24 N/A LB/D N/A
5 Unit cost	25
ools and Models 6 Have other water quality tools or models been applied to your site?	26 YES C NO
(NOWN PROBLEMS	100
exceedances of Permit Limits	
Г	27 YES ONO
	BOD5 COD
8 If so, what is the highest observed daily concentration? (mg/L)	28
	29 YES O NO
	BOD5 COD
If so, what is the highest observed daily load? (lbs/day)	30
Other Known Problems	
Г	31 YES ONO
Description of the negative environmental consequence (optional)	
reatment Issues 2 Are costs of treatment for collected deicer fluid excessive?	32

Figure 1. Evaluation Worksheet for Alternative Deicer Fluids

These figures are screen captures of the working decision support tool that may be difficult to read at this size printed out or on a computer screen. Larger-size copies of these figures are included in Attachment 2 for printing on tabloid (11"x17") paper; users may elect to open the accompanying spreadsheet, Evaluation Worksheet.xls, to better view the decision support tool inputs on a computer screen.

haracteristics of Alternative Deicer  1 Name of alternative deicer 5 Decay rate at 20°C (1/day) 5 Specific gravity 7 BOD5 concentration 6 BOD5 units for alternative deicer 9 96-hour aquatic toxicity (LC50) for minnows (mg/L) 4 48-hour aquatic toxicity (LC50) for daphnia (mg/L) 1 Aquatic toxicity (LC50) for other organisms (mg/L) 2 Name of other organism 3 Cost of alternative deicer product at purchased concentration (\$'gallon) 1 Typical application strength of purchased alternative deicer (100% = no dilution of product	34 35 36 37 38 MG/L <u>*</u> 39 40 41	
5 Decay rate at 20°C (1/day) 5 Specific gravity 7 BOD5 concentration 8 BOD5 units for alternative deicer 9 96-hour aquatic toxicity (LC50) for minnows (mg/L) 4-8-hour aquatic toxicity (LC50) for daphnia (mg/L) 1 Aquatic toxicity (LC50) for other organisms (mg/L) 2 Name of other organism 3 Cost of alternative deicer product at purchased concentration (\$(gallon))	36 37 38 MG/L 39 40 41 42	
S Specific gravity 7 BOD5 concentration 8 BOD5 units for alternative deicer 9 96-hour aquatic toxicity (LC50) for minnows (mg/L) 48-hour aquatic toxicity (LC50) for daphnia (mg/L) 1 Aquatic toxicity (LC50) for other organisms (mg/L) 2 Name of other organism 3 Cost of alternative deicer product at purchased concentration (\$(gallon))	36 37 38 MG/L 39 40 41 42	
7 BOD5 concentration 8 BOD5 units for alternative deicer 9 96-hour aquatic toxicity (LC50) for minnows (mg/L) 1 48-hour aquatic toxicity (LC50) for daphnia (mg/L) 1 4quatic toxicity (LC50) for other organisms (mg/L) 2 Name of other organism 3 Cost of alternative deicer product at purchased concentration (\$(gallon))	37 38 MG/L T 39 40 41	
B DOD5 units for alternative deicer 9 6-hour aquatic toxicity (LC50) for minnows (mg/L) 48-hour aquatic toxicity (LC50) for daphnia (mg/L) 4 quatic toxicity (LC50) for other organisms (mg/L) Name of other organism Cost of alternative deicer product at purchased concentration (\$\frac{1}{2}\text{gallon})	38 MG/L T 39 40 41 42	
9 96-hour aquatic toxicity (LC50) for minnows (mg/L)  1 48-hour aquatic toxicity (LC50) for daphnia (mg/L)  1 Aquatic toxicity (LC50) for other organisms (mg/L)  2 Name of other organism  3 Cost of alternative deicer product at purchased concentration (\$(gallon))	39 40 41 42	
48-hour aquatic toxicity (LC50) for daphnia (mg/L)     Aquatic toxicity (LC50) for other organisms (mg/L)     Name of other organism     Osst of alternative deicer product at purchased concentration (\$/gallon)	41 42	
Aquatic toxicity (LC50) for other organisms (mg/L) Name of other organism Cost of alternative deicer product at purchased concentration (\$(gallon)	41 42	
2 Name of other organism 3 Cost of alternative deicer product at purchased concentration (\$/gallon)	42	
3 Cost of alternative deicer product at purchased concentration (\$/gallon)		
	43	
	44	
5 Gallons of alternative deicer to achieve effectiveness of 1 gallon of PG-based deicer	45	
npact on Permit Exceedances	BOD5 COD	
B Estimated new maximum daily concentration (mg/L)	46 N/A N/A	
7 Compliance with permit limit on concentration likely?	47 N/A N/A	
B Estimated new maximum daily load (mg/L)	48 N/A N/A	
Compliance with permit limit on load likely?	49 N/A N/A	
npact on Treatment		
D Estimated reduction in treatment charges	50	
Estimated maximum daily BOD load for treatment (lbs)	51	
2 Treatment flowthrough improvement	52	
npact on Oxygen Depletion (minimum dissolved oxygen in receiving waters)		
B Do you discharge to a river or stream?	53 YES ONO	
	Upstream Discharge	
Dissolved oxygen concentration (mg/L)	54	
5 Temperature (°C)	55	
Stream flow (typical) during deicing discharges (cfs)	56	
7 Upstream BOD5 (mg/L)	57	
3 Stream reaeration coefficient at 20°C (1/day) (estimate below or enter a value)	58 (Estimate not ava	ailabl
a Stream depth (feet) (required)	a	
b Stream width (feet) (width or velocity required, both may be entered if available)	b	
c Stream velocity (fps) (width or velocity required, both may be entered if available)	С	
d Slope (optional)	d	
e Stream character (unknown, pool and riffle, or channel control)	e Unknown	
B Estimated improvement in minimum dissolved oxygen (mg/L)	59 N/A	
npact on Purchases of Product	New Change	
D Estimated annual new product purchases (gallons) and change from current purchases	60	
Estimated annual new product purchase costs (\$) and change from current cost	61	
UMMARY OF POTENTIAL BENEFITS OF NEW PRODUCT		
quatic Toxicity		
No comparison for minnow LC50 possible		
No comparison for daphnia LC50 possible		
No comparison for 0 LC50 possible		
reatment		
Annual cost to treat collected deicing fluid is estimated to be reduced by		
Maximum amount of BOD collected in a day for eventual treatment estimated at lbs		
Flowthrough rate for treatment process is estimated to improve by , allowing faster drawdo	vn of storage during prolonged ever	nts.
ermit Compliance		
Compliance with permit limits for maximum daily concentration not evaluated		
Compliance with permit limits for maximum daily loads not evaluated		
ater Quality		
Impact on oxygen concentrations in receiving waters not evaluated		
urchases of Product		
ther		

Figure 1. Evaluation Worksheet for Alternative Deicer Fluids (continued)

These figures are screen captures of the working decision support tool that may be difficult to read at this size printed out or on a computer screen. Larger-size copies of these figures are included in Attachment 2 for printing on tabloid (11"x17") paper; users may elect to open the accompanying spreadsheet, Evaluation Worksheet.xls, to better view the decision support tool inputs on a computer screen.

The results of the analyses performed by the tool are presented in a summary list at the end of the worksheet The worksheet is designed to be printed out for examination and archiving. The Decision Support Tool and instructions are included as an electronic attachment to this document.

#### 3. CASE STUDIES

Three facilities were used to test the Decision Support Tool: 1) the Pennsylvania Air National Guard facility (PIT) located at the Pittsburgh International Airport, 2) the Maine Air National Guard facility (BNG) located at the Bangor International Airport, and 3) the Portland International Airport (PDX) in Portland, Oregon. The sites were selected to allow evaluation of the Decision Support Tool across a range of facility sizes, glycol usage rates, and collection strategies.

#### 3.1 CASE STUDY SUMMARIES

The three case studies are described in the following subsections.

#### 3.1.1 Pittsburgh ANG (PIT)

The Pittsburgh Air National Guard facility at the Pittsburgh International Airport is home to the 171<sup>st</sup> Air Refueling Wing. The 171<sup>st</sup> has a fleet of KC-135 tankers that conduct refueling missions, as well as cargo and passenger transport mission services. LTC John Tower, Environmental Coordinator provided daily ADF usage data for the seasons 2002-03 through 2006-07 for the Pittsburgh Air National Guard facility. Average annual reported glycol usage was 12,800 gallons and ranged from a minimum of 9,600 gallons to a maximum of 17,600 gallons during the 2006-07 and 2003-04 seasons, respectively. Recovery data for the 2005-06 and 2006-07 seasons was also provided. The average calculated seasonal collection efficiency estimate of 29% was developed based upon conversations with LTC Tower regarding glycol recovery vehicle (GRV) performance and using the average concentration of glycol observed in truck loads for which glycol concentrations were measured during each season.

The application of the Decision Support Tool to the Pittsburgh ANG facility is shown in Figure 2. The following highlights of the analysis summarize the case study findings:

- Because information regarding PIT's NPDES permit was not provided, an evaluation of potential permit compliance implications was not conducted.
- The following benefits are indicated for the theoretical replacement of conventional PG-based ADF product with one having characteristics similar to LBOD ADF:
  - Estimated reduction in annual treatment costs for collected runoff of approximately \$22,000 and the flow through rate of the collection system is estimated to increase by approximately 180%.
  - Reduced aquatic toxicity in deicing discharges.
  - Savings of approximately \$20,000 annually due to the decreased unit cost of the alternative ADF product.

EVALUATION WORKSHEET FOR ALTERNATIVE AIRCRAFT DEICERS	
This evaluation tool was designed to assist a Base Environmental Manager (EM) in assessing the	he likely environmental, regulatory
compliance, and cost implications of a new Type I ADF formulation that is being considered as a	
in use. The evaluation is at a screening level, intended to give the EM a sound indication of the	
changes and benefits that can be expected with a switch to the alternative ADF. This information	
regarding a switch to the new formulation.	
It is essential to understand that the tool is not intended to replace more sophisticated analyses	that may be required to support
demonstrations of regulatory compliance or engineering design of deicing runoff management s	
	oyutomo.
SITE INFORMATION Site Name	
Pittsburgh ANG	
Address	
Person filling out form	
Chris Cieciek, LimnoTech on behalf of LTC John Towers	
E-mail Address	Telephone Number
ccieciek@limno.com	
CURRENT SITUATION	
NPDES Storm Water Permit Information	
1 Does your site have an NPDES Storm Water permit for discharge of deicing runoff?	1 YES NO
2 NPDES permit number	2
3 Permitting authority	3
Permit limits during periods of peak deicing activity	BOD5 COD
4 Most stringent permitted discharge concentration (mg/L). Leave blank if there are no limits.	4
5 Most stringent permitted maximum daily load (lbs/day). Leave blank if there are no limits.	5
Current Type I Deicer Information (See MSDS and manufacturer's literature)	Type I
6 Decay rate at 20°C (1/day)	6 0.18
7 BOD5 concentration of propylene glycol (mg/L)	7 650,000
8 Percent glycol in purchased product	8 88.00%
BOD5 concentration in the purchased product (mg/L)	9 572,000
10 96-hour aquatic toxicity (LC50) for fathead minnows (mg/L)	10 10,800
11 48-hour aquatic toxicity (LC50) for daphnia (mg/L)	11 14,000
12 Aquatic toxicity (LC50) for other organisms (mg/L)	12
13 Name of other test organism	13 Test
14 Annual volume of applied aircraft deicer mixture (gallons at working concentration)	14 25,000
15 Maximum daily volume of applied aircraft deicer mixture (gallons at working concentration)	<del></del>
16 Typical application strength of purchased deicer (100% = no dilution of purchased product)	
17 Calculated annual volume of aircraft deicer at purchased concentration (gallons)	17 12,500
18 Cost of aircraft deicer at purchased concentration (\$/gallon)	18 \$8.63
Deicer Collection and Storage	
19 Do you collect deicing runoff for storage and treatment?	19 YES NO
20 Collection technique	20 Sweeper vacs (25-35%)
21 Estimated collection efficiency (percent of applied glycol)	21 29%
22 Estimated losses of uncollected deicer fluid (percent of applied glycol)	22 30%
Treatment Information 23 Maximum daily amount accepted for treatment	Flow BOD5 COD
24 Units	24 GPM T LB/D T N/A T
25 Unit cost	25 0.22 NAX
Tools and Models	
26 Have other water quality tools or models been applied to your site?	26 CYES © NO
KNOWN PROBLEMS	
Exceedances of Permit Limits	
27 Do you periodically exceed your concentration limits for BOD5 or COD?	27 C YES © NO
20 If an unbat in the highest observed doily concentration (Arrall )	BOD5 COD 28 140
28 If so, what is the highest observed daily concentration? (mg/L)	
29 Do you exceed daily load limits for BOD5 or COD?	
30 If so, what is the highest observed daily load? (lbs/day)	BOD5 COD 30 700
Other Known Problems	
31 Are there known negative environmental consequences of deicing discharges?	31 C YES © NO
Description of the negative environmental consequence (optional)	
Treatment Issues	
	32 C YES © NO
32 Are costs of treatment for collected deicer fluid excessive? 33 Is existing treatment and onsite storage capacity adequate for needs?	33

Figure 2. Pittsburgh ANG Evaluation

These figures are screen captures of the working decision support tool that may be difficult to read at this size printed out or on a computer screen. Larger-size copies of these figures are included in Attachment 2 for printing on tabloid (11"x17") paper; users may elect to open the accompanying spreadsheet, Evaluation Worksheet ANG.xls, to better view the decision support tool inputs on a computer screen.

Characteristics of Alternative Deicer				
34 Name of alternative deicer	24	LBOD		
35 Decay rate at 20°C (1/day)	35	0.04		
36 Specific gravity	36	1.154		
37 BOD5 concentration	37	270,000		
38 BOD5 units for alternative deicer	38	MG/L -		
39 96-hour aquatic toxicity (LC50) for minnows (mg/L)	39	9,725		
40 48-hour aquatic toxicity (LC50) for daphnia (mg/L)	40	4,275		
41 Aquatic toxicity (LC50) for other organisms (mg/L)	41			
42 Name of other organism	42	Test		
43 Cost of alternative deicer product at purchased concentration (\$/gallon)	43	\$7.00		
44 Typical application strength of purchased alternative deicer (100% = no dilution of product)	44	50%		
45 Gallons of alternative deicer to achieve effectiveness of 1 gallon of PG-based deicer	45	1.00		
Impact on Permit Exceedances		BOD5	COD	
46 Estimated new maximum daily concentration (mg/L)	46	N/A	N/A	
47 Compliance with permit limit on concentration likely?	47	N/A	N/A	
48 Estimated new maximum daily load (mg/L)	48	N/A	N/A	
49 Compliance with permit limit on load likely?	49	N/A	N/A	
Impact on Treatment				
50 Estimated reduction in treatment charges	50	\$22,147		
51 Estimated maximum daily BOD load for treatment (lbs)	51	3,114		
52 Treatment flowthrough improvement	52	178%		
Impact on Oxygen Depletion (minimum dissolved oxygen in receiving waters)			·	
53 Do you discharge to a river or stream?	53	· YES	○ NO	
, ,		Upstream	Discharge	
54 Dissolved oxygen concentration (mg/L)	54	9.0	5.0	
55 Temperature (°C)	55	5.0	2.0	
56 Stream flow (typical) during deicing discharges (cfs)	56	5.00		
57 Upstream BOD5 (mg/L)	57	1.0		
58 Stream reaeration coefficient at 20°C (1/day) (estimate below or enter a value)	58		(Estimate not av	ailabl
a Stream depth (feet) (required)	а			
b Stream width (feet) (width or velocity required, both may be entered if available)	b			
c Stream velocity (fps) (width or velocity required, both may be entered if available)	C			
d Slope (optional)	d			
e Stream character (unknown, pool and riffle, or channel control)	e 59	Unknown N/A	-	
59 Estimated improvement in minimum dissolved oxygen (mg/L)	09			
Impact on Purchases of Product	-	New	Change	
60 Estimated annual new product purchases (gallons) and change from current purchases	60		No change	
61 Estimated annual new product purchase costs (\$) and change from current cost	61	\$87,500	-\$20,375	
SUMMARY OF POTENTIAL BENEFITS OF NEW PRODUCT				
Aquatic Toxicity				
Reported aquatic toxicity as measured by minnow LC50 improves (10,800 mg/L to 9,725 m	ıa/L)			
Reported aquatic toxicity as measured by daphnia LC50 improves (14,000 mg/L to 4,275 m				
No comparison for Test LC50 possible	·9·-/			
Treatment				
Annual cost to treat collected deicing fluid is estimated to be reduced by \$22,147				
Maximum amount of BOD collected in a day for eventual treatment estimated at 3,114 lbs				
Flowthrough rate for treatment process is estimated to improve by 178%, allowing faster dra	awdo	wn of storage	e durina prolonae	d eve
Permit Compliance			5 (94	
Compliance with permit limits for maximum daily concentration not evaluated				
Compliance with permit limits for maximum daily loads not evaluated				
Water Quality				
Impact on oxygen concentrations in receiving waters not evaluated				
Purchases of Product				
No changes expected in volume of product purchased annually				
Decrease of \$20,375 in annual costs				

Figure 2. Pittsburgh ANG Evaluation (continued)

These figures are screen captures of the working decision support tool that may be difficult to read at this size printed out or on a computer screen. Larger-size copies of these figures are included in Attachment 2 for printing on tabloid (11"x17") paper; users may elect to open the accompanying spreadsheet, Evaluation Worksheet ANG.xls, to better view the decision support tool inputs on a computer screen.

#### 3.1.2 Maine ANG (MEANG)

The Maine Air National Guard facility at the Bangor International Airport (BGR) is home to the 101<sup>st</sup> Air Refueling Wing. 101 ARW flies KC-135 aircraft in support of refueling and transport missions. The unit has a high OPSTEMPO relative to other ANG units consistently delivering over 12 million gallons of fuel per year and receiving over 650 transients per year. LTC D. Eric Johns, Environmental Manager at the MEANG facility provided daily ADF usage and sanitary sewer discharge data for collected ADF runoff for the seasons 2003-04 through 2006-07. Average annual reported glycol usage was 25,700 gallons and ranged from a minimum of 17,200 gallons to a maximum of 36,200 gallons during the 2003-04 and 2006-07 seasons, respectively. Sanitary sewer discharge data was compared to usage data to calculate collection efficiency estimates for each season. The average collection efficiency was 50%, and ranged from a minimum of 45% to a maximum of 56% during the 2003-04 and 2006-07 seasons, respectively.

The application of the Decision Support Tool to the MEANG facility is shown in Figure 3. The following highlights of the analysis summarize the case study findings:

- Because BNG's NPDES permit does not contain numeric limits for its storm water discharge, an evaluation of potential permit compliance benefits was not conducted.
- The following benefits are indicated for the theoretical replacement of conventional PG-based ADF product with one having characteristics similar to LBOD ADF:
  - Reduction in annual treatment costs for collected runoff of approximately \$78,000 and the flow through rate of the collection system is estimated to increase by approximately 180%.
  - Reduced aquatic toxicity in deicing discharges.
  - Savings of approximately \$42,000 annually due to the decreased unit cost of the alternative ADF product.
- The Decision Support Tool notes that other known environmental consequences were indicated (e.g. reduced oxygen levels and invertebrates) and suggests that other more sophisticated water quality models or tools may be appropriate to provide a more detailed analysis.

current Type I Deicer Information (See MSDS and manufacturer's literature)  8 Decay rate at 20°C (1/day)  7 BODS concentration in the purchased product (mg/L)  8 Percent glycol in purchased product (mg/L)  9 BODS concentration in the purchased product (mg/L)  10 98-hour aquatic toxicity (LC50) for fathead minnows (mg/L)  10 20/3	increase Number  200-100  Type I 0.18 650,000  10,800  10,800  10,800  10,800  10,800
in use. The evaluation is at a screening level, intended to give the EM a sound indication of the generohanges and benefits that can be expected with a switch to the alternative ADF. This information is integrating a switch to the new formulation.  It is essential to understand that the tool is not intended to replace more sophisticated analyses that in demonstrations of regulatory compliance or engineering design of delcing runoff management system and demonstrations of regulatory compliance or engineering design of delcing runoff management system SITE INFORMATION  Site Name Bangor ANG  Address  101 ARWIEM 99 Glenn Ave Suite 494 Bangor IAP, ME 04401  Person filing out from  Lt Col D Eric Johns, Environmental Manager  Enail Address  102 ARWIEM 99 Glenn Aver Suite 494 Bangor IAP, ME 04401  Person filing out from  Lt Col D Eric Johns, Environmental Manager  Enail Address encit Johns, Environmental Manager  Enail Address and Address and August Address and August	ral direction and magnitude of tended to support decisions may be required to support this support the support that is supported to support the support that is support to support the support that is support to support the support that is supported to support the support that is supported to support the support that is supported to support the support the support to support the support the support to support the support the support to support the support to support the support to support the support to support the support the support to support t
changes and benefits that can be expected with a switch to the alternative ADF. This information is integrarding a switch to the new formulation.  It is essential to understand that the tool is not intended to replace more sophisticated analyses that in demonstrations of regulatory compliance or engineering design of deicing runoff management system.  SITE INFORMATION  Sie Name Bangor ANG  Address  Total TARWIEM 99 Glenn Ave Suite 494 Bangor IAP, ME 04401  Person filing out form  LLCOLD Eric Johns, Environmental Manager  E-mail Address  Teles and Address  CURRENT SITUATION  NPDES Storm Water Permit Information  1 Does your site have an NPDES Storm Water permit for discharge of deicing runoff?  2 NPDES permit number  3 Permitting authority  Permit Ilmits during periods of peak deicing activity  4 Most stringent permitted discharge concentration (mg/L), Leave blank if there are no limits.  5 Most stringent permitted maximum daily load (listiday), Leave blank if there are no limits.  5 Most Stringent permitted maximum daily load (listiday), Leave blank if there are no limits.  6 Decay rate at 20°C (1/day)  7 BOD5 concentration of propylene glycol (mg/L)  8 Percent glycol in purchased product  8 POS born aquatic toxicity (LC50) for fathead minnows (mg/L)  10 99-hour aquatic toxicity (LC50) for daphnia (mg/L)  11 48-hour aquatic toxicity (LC50) for daphnia (mg/L)  12 Aquatic toxicity (LC50) for daphnia (mg/L)  13 Name of other test organisms  13 Name of other test organisms  14 Annual volume of applied aircraft deicer mixture (gallons at working concentration)  15 Maximum daily volume of applied aircraft deicer mixture (gallons at working concentration)  15 Total calculated annual volume of aircraft deicer mixture (gallons at working concentration)  15 Total calculated annual volume of aircraft deicer effect of the organisms (mg/L)  16 Typical application strength of purchased deicer (100% e no dilution of purchased product)  16 Total calculated annual volume of aircraft deicer at purchased concentration (gallons)	rended to support decisions  may be required to support ms.  Per support m
It is essential to understand that the loof is not intended to replace more sophisticated analyses that in demonstrations of regulatory compiliance or engineering design of delicing runoff management system.  Site INFORMATION  Site Name  Bangor ANG  Address  101 ARWINEM 99 Glenn Ave Suite 494 Bangor IAP, ME 04401  Person filing out form.  Lt Coll D. Eric Johns, Environmental Manager  E-mail Address  1 Feles  Fired Address  1 Feles  CURRENT SITUATION  NPDES Storm Water Permit Information  1 Does your site have an NPDES Storm Water permit for discharge of deicing runoff?  2 NPDES permit Innitia during periods of peak deicing activity  4 Most stringent permitted discharge concentration (mg/L). Leave blank if there are no limits.  5 Most stringent permitted discharge concentration (mg/L). Leave blank if there are no limits.  5 Decay rate at 20°C (1/day)  7 BODS concentration of propylene glycol (mg/L)  8 Percent glycol in purchased product  9 BODS concentration in the purchased product (mg/L)  10 98-hour aquatic toxicity (LC50) for daphnia (mg/L)  11 Aquatic toxicity (LC50) for other organisms (mg/L)  12 Aquatic toxicity (LC50) for other organisms (mg/L)  13 Name of other test organism  14 Annual volume of applied aircraft deicer mixture (gallons at working concentration)  15 Typical application strength of purchased deicer (100% – no dilution of purchased product)  16 Typical application strength of purchased deicer (100% – no dilution of purchased product)  17 Total culated annual volume of applied aircraft deicer mixture (gallons at working concentration)  18 Cost of aircraft deicer at purchased concentration (signilon)  19 Do you collect deicing runoff for storage and treatment?  19 Do you collect deicing runoff for storage and treatment?  20 Collection edicinique  21 Estimated collection efficiency (percent of applied glycol)	inay be required to support ins services in the support
It is essential to understand that the tool is not intended to replace more sophisticated analyses that in demonstrations of regulatory compliance or engineering design of deloing runoff management system is the property of the property o	ince Number   100
demonstrations of regulatory compliance or engineering design of deloing runoff management syster  SITE INFORMATION  Site Name Bangor ANG  Address  101 ARWIEM 99 Glenn Ave Suite 494 Bangor IAP, ME 04401  Peace flig out from  LL Col D. Eric Johns, Environmental Manager  Enail Address    College	ince Number   100
SITE INFORMATION  Size Name Bangor ANG  Address  IT of JARWIEM 99 Glenn Ave Suite 494 Bangor IAP, ME 04401  Person filing out form  Lt Col ID Eric Johns, Environmental Manager  E-mail Address  IT of Size Name  Both Storm Water Permit Information  1 Does your site have an NPDES Storm Water permit for discharge of deicing runoff?  2 NPDES Storm Water Permit Information  1 Does your site have an NPDES Storm Water permit for discharge of deicing runoff?  2 NPDES permit number  3 Permitting authority  Permit limits during periods of peak deicing activity  4 Most stringent permitted discharge concentration (mg/L), Leave blank if there are no limits.  5 Most stringent permitted maximum daily load (lbsiday), Leave blank if there are no limits.  6 Decay rate at 20°C (1/day)  7 BOD5 concentration of propylene glycol (mg/L)  8 PBOD5 concentration of propylene glycol (mg/L)  9 PBOD6 concentration in the purchased product (mg/L)  10 99-hour aquatic toxicity (LC50) for dahenia (mg/L)  11 48-hour aquatic toxicity (LC50) for dahenia (mg/L)  12 Aquatic toxicity (LC50) for dahenia (mg/L)  13 Name of ofher test organisms  13 Name of other test organisms  13 Name of other test organisms  13 Name of other test organisms  14 Annual volume of applied aircraft deicer mixture (gallons at working concentration)  15 Maximum daily volume of applied aircraft deicer mixture (gallons at working concentration)  15 To yicical application strength of purchased deicer (100% e no dilution of purchased product)  16 To yicical application strength of purchased deicer (100% e no dilution of purchased product)  16 To yicical application strength of purchased deicer mixture (gallons at working concentration)  15 Maximum daily volume of applied aircraft deicer mixture (gallons at working concentration)  16 To yicical application strength of purchased deicer (100% e no dilution of purchased product)  17 Calculated annual volume of aircraft deicer at purchased concentration (gallons)  18 Deicer Collection and Storage  19 Do you collect deicing runoff for	Type 1 0.19 650,000 88.00% 6572,000 10,800
Site Name Bangor ANG  Address  101 ARWIEM 99 Glenn Ave Suite 494 Bangor IAP, ME 04401  Person filing out form  Lt Col D Eric Johns, Environmental Manager  Eanal Address  (Current Tylat TUATION)  NPDES Storm Water Permit Information  1 Does your site have an NPDES Storm Water permit for discharge of deicing runoff?  2 NPDES permit number  3 Permitting authority  3 Permitting authority  3 Permitting authority  3 Permitting authority  3 Permitting permited discharge concentration (mgl.). Leave blank if there are no limits.  5 Most stringent permitted dascharge concentration (mgl.). Leave blank if there are no limits.  6 Decay rate at 20°C (1/day)  7 BOD5 concentration of propylene glycol (mgl.)  8 Percent glycol in purchased product  9 BOD5 concentration in the purchased product (mgl.)  10 99-hour aquatic toxicity (LC50) for dahenal minnows (mgl.)  11 49-hour aquatic toxicity (LC50) for dahenal minnows (mgl.)  11 Aquatic toxicity (LC50) for dahenal minnows (mgl.)  12 Aquatic toxicity (LC50) for dahenal minnows (mgl.)  13 Name of other test organism  14 Annual volume of applied aircraft deicer mixture (gallons at working concentration)  15 Maximum daily volume of applied aircraft deicer mixture (gallons at working concentration)  15 To zlaculated annual volume of apropried aircraft deicer mixture (gallons at working concentration)  16 Typical application strength of purchased deicer (100% – no dilution of purchased product)  16 To zlaculated annual volume of aircraft deicer at purchased concentration (gallons)  17 Calculated annual volume of aircraft deicer at purchased concentration (gallons)  18 Does on collected deicing runoff for storage and treatment?  19 Do you collect deicing runoff for storage and treatment?  20 Collection edicing runoff for storage and treatment?	P90-7407  PYES NO MEROSA911  MEROSA911  Maine DEP  BODS COD  100  Type I  0.19 650,000 88.00% 572,000 10,800
Bangor ANG  Address  In Col D. Eric Johns, Environmental Manager  Email Address  In Col D. Eric Johns, Environmental Manager  Email Address  In Col D. Eric Johns, Environmental Manager  Email Address  In Col D. Eric Johns, Environmental Manager  Email Address  In Col D. Eric Johns, Environmental Manager  Email Address  In Col D. Eric Johns, Environmental Manager  In Col D. Emil Marker Permit Information  In Does your site have an NPDES Storm Water permit for discharge of deicing runoff?  In Does your site have an NPDES Storm Water permit for discharge of deicing runoff?  In Does your site have an NPDES Storm Water permit for discharge of deicing runoff?  In Does your site have an NPDES Storm Water permit for discharge of deicing runoff?  In PERMIT In Institution of Propiets of peak delcing activity  In Most stringent permitted discharge concentration (mg/L), Leave blank if there are no limits.  In December In December Information (See MSDS and manufacturer's literature)  In December In December Information (See MSDS and manufacturer's literature)  In December In December Information (See MSDS and manufacturer's literature)  In December In December Information (See MSDS and manufacturer's literature)  In December Information (See MSDS and manufacturer's literature)  In December Information (See MSDS and manufacturer's literature)  In Benche Concentration in the purchased product (mg/L)  In Genour aquatic toxicity (LCSD) for fathead minnows (mg/L)  In Genour aquatic toxicity (LCSD) for fathead minnows (mg/L)  In Genour aquatic toxicity (LCSD) for fathead minnows (mg/L)  In Genour aquatic toxicity (LCSD) for fathead minnows (mg/L)  In Genour aquatic toxicity (LCSD) for fathead minnows (mg/L)  In Genour aquatic toxicity (LCSD) for fathead minnows (mg/L)  In Genour aquatic toxicity (LCSD) for fathead minnows (mg/L)  In Genour aquatic toxicity (LCSD) for fathead minnows (mg/L)  In Genour aquatic toxicity (LCSD) for fathead minnows (mg/L)  In Genour aquatic toxicity (LCSD) for fathead minnows (mg/L)  In Genour aquatic	P90-7407  PYES NO MEROSA911  MEROSA911  Maine DEP  BODS COD  100  Type I  0.19 650,000 88.00% 572,000 10,800
Teleprocess	P90-7407  PYES NO MEROSA911  MEROSA911  Maine DEP  BODS COD  100  Type I  0.19 650,000 88.00% 572,000 10,800
LL COID. Eric Johns, Environmental Manager    Telegraphic Johns	P90-7407  PYES NO MEROSA911  MEROSA911  Maine DEP  BODS COD  100  Type I  0.19 650,000 88.00% 572,000 10,800
Telegrams   Tele	P90-7407  PYES NO MEROSA911  MEROSA911  Maine DEP  BODS COD  100  Type I  0.19 650,000 88.00% 572,000 10,800
CURRENT SITUATION  NPDES Storm Water Permit Information  1 Does your site have an NPDES Storm Water permit for discharge of deicing runoff?  2 NPDES permit number  3 Permitting authority  Permit limits during periods of peak deicing activity  4 Most stringent permitted discharge concentration (mg/L). Leave blank if there are no limits.  5 Most stringent permitted maximum daily load (lbs/day). Leave blank if there are no limits.  5 Most stringent permitted maximum daily load (lbs/day). Leave blank if there are no limits.  6 Most stringent permitted maximum daily load (lbs/day). Leave blank if there are no limits.  7 Most stringent permitted maximum daily load (lbs/day). Leave blank if there are no limits.  8 Most stringent permitted maximum daily load (lbs/day). Leave blank if there are no limits.  6 Decay rate at 20°C (1/day)  7 BOD5 concentration of propylene glycol (mg/L)  8 Percent glycol in purchased product (mg/L)  9 BOD5 concentration in the purchased product (mg/L)  10 98-hour aquatic toxicity (LC50) for fathead minnows (mg/L)  11 48-hour aquatic toxicity (LC50) for daphnia (mg/L)  12 Aquatic toxicity (LC50) for daphnia (mg/L)  13 Name of ofher test organisms  13 Name of ofher test organisms  13 Name of other test organisms  14 Annual volume of applied aircraft deicer mixture (gallons at working concentration)  15 Maximum daily volume of applied aircraft deicer mixture (gallons at working concentration)  15 To Zalculated annual volume of aircraft deicer at purchased concentration (gallons)  16 To yicial application strength of purchased deicer (100% – no dilution of purchased producty)  16 To yicial application strength of purchased deicer mixture (gallons at working concentration)  16 To you collect deicing runoff for storage and treatment?  17 Calculated annual volume of aircraft deicer at purchased concentration (gallons)  18 Deicer Collection and Storage  19 Do you collect deicing runoff for storage and treatment?  20 Collection technique  21 Estimated collection efficiency (percent of applied glycol	YES NO MER05A911 Maine DEP  8005 COD  100  Type I 0.18 850,000 88,00% 6572,000 10,800
NPDES Storm Water Permit Information  1 Does your site have an NPDES Storm Water permit for discharge of deicing runoff?  2 NPDES permit number  3 Permitting authority  Permit limits during periods of peak delcing activity  4 Most stringent permitted discharge concentration (mg/L). Leave blank if there are no limits.  5 Most stringent permitted discharge concentration (mg/L). Leave blank if there are no limits.  5 Most stringent permitted maximum daily load (lbs/day). Leave blank if there are no limits.  6 Most stringent permitted maximum daily load (lbs/day). Leave blank if there are no limits.  6 Most stringent permitted maximum daily load (lbs/day). Leave blank if there are no limits.  6 Most stringent permitted maximum daily load (lbs/day). Leave blank if there are no limits.  6 Most stringent permitted maximum daily load (lbs/day). Leave blank if there are no limits.  6 Most stringent permitted maximum daily load (lbs/day). Leave blank if there are no limits.  6 Most stringent permitted maximum daily load (lbs/day). Leave blank if there are no limits.  6 Most stringent permitted maximum daily load (lbs/day). Leave blank if there are no limits.  6 Most stringent permitted maximum daily load (lbs/day). Leave blank if there are no limits.  6 Most stringent permitted maximum daily load (lbs/day). Leave blank if there are no limits.  6 Most stringent permitted in there are no limits.  6 Most stringent permitted annum sundum of propylene glycol (mg/L)  10 Polyon at 20 Most stringent permitted blank if there are no limits.  11 Annual volume of applied aircraft deicer mixture (gallons at working concentration)  12 Aquatic toxicity (LC50) for dahnia (mg/L)  13 Name of ofher test organism  14 Annual volume of applied aircraft deicer mixture (gallons at working concentration)  14 Most stringent permitted permitted permitted permitted permitted permitted annual volume of aircraft deicer mixture (gallons at working concentration)  15 Most stringent permitted annual volume of aircraft deicer mixture (gallons at working	MER054911 Maine DEP  8005 COD  100  Type I  0.18  850,000  88,006  672,000  10,800
1 Does your site have an NPDES Storm Water permit for discharge of deicing runoff? 2 NPDES permit number 3 Permitting authority  Permit limits during periods of peak deicing activity 4 Most stringent permitted discharge concentration (mg/L). Leave blank if there are no limits. 5 Most stringent permitted discharge concentration (mg/L). Leave blank if there are no limits. 5 Most stringent permitted maximum daily load (lisd'day). Leave blank if there are no limits. 5 Most stringent permitted maximum daily load (lisd'day). Leave blank if there are no limits. 6 Most stringent permitted maximum daily load (lisd'day). Leave blank if there are no limits. 7 Most permit permitted maximum daily load (lisd'day). Leave blank if there are no limits. 8 Percent glycol in purchased product (mg/L) 9 RoD5 concentration of propylene glycol (mg/L) 9 BOD5 concentration in the purchased product (mg/L) 9 BOD5 concentration in the purchased product (mg/L) 10 98-hour aquatic toxicity (LC50) for fathead minnows (mg/L) 11 48-hour aquatic toxicity (LC50) for daphnia (mg/L) 12 Aquatic toxicity (LC50) for daphnia (mg/L) 13 Name of often test organisms 13 Name of often test organisms 13 Name of often test organisms 14 Annual volume of applied aircraft deicer mixture (gallons at working concentration) 15 Maximum daily volume of applied aircraft deicer mixture (gallons at working concentration) 16 Totalculated annual volume of aircraft deicer at purchased concentration (gallons) 17 Totalculated annual volume of aircraft deicer at purchased concentration (gallons) 18 Deicer Collection and Storage 19 Do you collect deicing runoff for storage and treatment? 20 Collection technique 20 Collection technique 21 Estimated collection efficiency (percent of applied glycol)	MER054911 Maine DEP  8005 COD  100  Type I  0.18  850,000  88,006  672,000  10,800
2 NPDES permit number 3 Permitting authority 4 Most stringent permitted discharge concentration (mg/L). Leave blank if there are no limits. 5 Most stringent permitted discharge concentration (mg/L). Leave blank if there are no limits. 5 Most stringent permitted maximum daily load (lbs/day). Leave blank if there are no limits. 5 Most stringent permitted maximum daily load (lbs/day). Leave blank if there are no limits. 6 Decay rate at 20°C (1/day) 7 BOD5 concentration of propylene glycol (mg/L) 8 Percent glycol in purchased product 9 BOD5 concentration in the purchased product (mg/L) 9 BOD5 concentration in the purchased product (mg/L) 10 96-hour aquatic toxicity (LC50) for fathead minnows (mg/L) 11 48-hour aquatic toxicity (LC50) for fathead minnows (mg/L) 12 Aquatic toxicity (LC50) for other organisms (mg/L) 13 Name of other test organism 14 Annual volume of applied aircraft deicer mixture (gallons at working concentration) 14 Maximum daily volume of applied aircraft deicer mixture (gallons at working concentration) 15 Maximum daily volume of applied aircraft deicer mixture (gallons at working concentration) 16 Typical application strength of purchased deicer (100% – no dilution of purchased product) 16 Typical application strength of purchased deicer (100% – no dilution of purchased product) 16 Typical application strength of purchased deicer (100% – no dilution of purchased product) 17 Calculated annual volume of aircraft deicer at purchased concentration (gallons) 18 Cost of aircraft deicer at purchased concentration (signallon) 19 Do you collect deicing runoff for storage and treatment? 20 Collection technique 21 Estimated collection efficiency (percent of applied glycol)	MER054911 Maine DEP  8005 COD  100  Type I  0.18  850,000  88,006  672,000  10,800
3 Permitting authority  Permitt limits during periods of peak deicing activity  4 Most stringent permitted discharge concentration (mg/L). Leave blank if there are no limits.  5 Most stringent permitted maximum daily load (lts/day). Leave blank if there are no limits.  5 Current Type I Deicer Information (See MSDS and manufacturer's literature)  6 Decay rate at 20°C (1/day)  7 BODS concentration of propylene glycol (mg/L)  8 Percent glycol in purchased product  9 BODS concentration in the purchased product (mg/L)  10 98-hour aquatic toxicity (LC50) for fathead minnows (mg/L)  11 48-hour aquatic toxicity (LC50) for daphnia (mg/L)  12 Aquatic toxicity (LC50) for other organisms (mg/L)  13 Name of other test organism  14 Annual volume of applied aircraft deicer mixture (gallons at working concentration)  15 Maximum daily volume of applied aircraft deicer mixture (gallons at working concentration)  16 Typical application strength of purchased deicer (100% – no diultion of purchased product)  17 Calculated annual volume of aircraft deicer at purchased concentration (gallons)  18 Cost of aircraft deicer at purchased concentration (gallons)  19 Do you collect deicing runoff for storage and treatment?  19 Do you collect deicing runoff for storage and treatment?	Maine DEP  8005 COD  100  1 Vive I  0.18  850,000  88,00%  872,000  10,800
Permit limits during periods of peak deicing activity  4 Most stringent permitted discharge concentration (mg/L). Leave blank if there are no limits.  5 Most stringent permitted maximum daily load (libs/day). Leave blank if there are no limits.  5 Current Type I Deicer Information (See MSDS and manufacturer's literature)  6 Decay rate at 20°C (1/day)  7 BOD5 concentration of propylene glycol (mg/L)  8 Percent glycol in purchased product  9 BOD5 concentration in the purchased product (mg/L)  9 BOD5 concentration in the purchased product (mg/L)  10 98-hour aquatic toxicity (LC50) for fathead minnows (mg/L)  11 48-hour aquatic toxicity (LC50) for daphnia (mg/L)  12 Aquatic toxicity (LC50) for olther organisms (mg/L)  13 Name of other test organism  14 Annual volume of applied aircraft deicer mixture (gallons at working concentration)  15 Maximum daily volume of applied aircraft deicer mixture (gallons at working concentration)  16 Typical application strength of purchased deicer (100% e no dilution of purchased product)  17 Calculated annual volume of aircraft deicer at purchased concentration (gallons)  18 Deicer Collection and Storage  19 Do you collect deicing runoff for storage and treatment?  19 Do you collect deicing runoff for storage and treatment?  20 Collection etchinique  21 Estimated collection efficiency (percent of applied glycol)	Type I 0.18 650,000 88.00% 572,000 10,800
4 Most stringent permitted discharge concentration (mg/L). Leave blank if there are no limits.  5 Most stringent permitted maximum daily load (lbs/day). Leave blank if there are no limits.  5 Current Type I Deicer Information (See MSDS and manufacturer's literature)  6 Decay rate at 20°C (1/day)  7 BODS concentration of propylene glycol (mg/L)  8 Percent glycol in purchased product (mg/L)  9 BODS concentration in the purchased product (mg/L)  19 BODS concentration in the purchased product (mg/L)  10 98-hour aquatic toxicity (LC50) for fathead minnows (mg/L)  11 48-hour aquatic toxicity (LC50) for fathead minnows (mg/L)  11 42 Aquatic toxicity (LC50) for daphnia (mg/L)  12 Anyaulic toxicity (LC50) for other organisms (mg/L)  13 Name of other test organism  14 Annual volume of applied aircraft deicer mixture (gallons at working concentration)  15 Maximum daily volume of applied aircraft deicer mixture (gallons at working concentration)  16 Typical application strength of purchased deicer (100% = no dilution of purchased product)  17 Calculated annual volume of aircraft deicer at purchased concentration (gallons)  18 Cost of aircraft deicer at purchased concentration (gallons)  18 Do you collect deicing runoff for storage and treatment?  19 Do you collect deicing runoff for storage and treatment?  20 Collection etchnique  21 Estimated collection efficiency (percent of applied glycol)	Type I 0.18 650,000 88.00% 6572,000 10,800
5 Most stringent permitted maximum daily load (lbs/day). Leave blank if there are no limits.  5 Current Type I Deicer Information (See MSDS and manufacturer's literature)  6 Decay rate at 20°C (1/day)  7 BOD5 concentration of propylene glycol (mg/L)  8 Percent glycol in purchased product  8 BOD5 concentration in the purchased product (mg/L)  9 BOD5 concentration in the purchased product (mg/L)  10 96-hour aquatic toxicity (LC50) for fathead minnows (mg/L)  11 48-hour aquatic toxicity (LC50) for daphnia (mg/L)  12 Aquatic toxicity (LC50) for other organisms (mg/L)  13 Name of other test organism  14 Annual volume of applied aircraft deicer mixture (gallons at working concentration)  14 Annual volume of applied aircraft deicer mixture (gallons at working concentration)  15 Maximum daily volume of applied aircraft deicer mixture (gallons at working concentration)  16 Typical application strength of purchased deicer (100% = no dilution of purchased product)  17 Calculated annual volume of aircraft deicer at purchased concentration (gallons)  18 Cost of aircraft deicer at purchased concentration (gallons)  18 Devicer Collection and Storage  19 Do you collect deicing runoff for storage and treatment?  20 Collection technique  21 Estimated collection efficiency (percent of applied glycol)	Type I 0.18 650,000 88.00% 572,000 10,800
6 Decay rate at 20°C (1/day)  7 BODS concentration of propylene glycol (mg/L)  8 Percent glycol in purchased product  9 BODS concentration in the purchased product (mg/L)  19 BODS concentration in the purchased product (mg/L)  19 BOS-bour aquatic toxicity (LC50) for fathead minnows (mg/L)  10 98-hour aquatic toxicity (LC50) for fathead minnows (mg/L)  11 4A-hour aquatic toxicity (LC50) for other organisms (mg/L)  12 Aquatic toxicity (LC50) for other organisms (mg/L)  13 Name of other test organism  14 Annual volume of applied aircraft deicer mixture (gallons at working concentration)  15 Maximum daily volume of applied aircraft deicer mixture (gallons at working concentration)  16 Typical application strength of purchased deicer (100% – no dilution of purchased product)  16 Totalculated annual volume of aircraft deicer at purchased concentration (gallons)  17 Calculated annual volume of aircraft deicer (100% – no dilution of purchased product)  18 Cost of aircraft deicer at purchased concentration (sigallon)  18 Deicer Collection and Storage  19 Do you collect deicing runoff for storage and treatment?  19 Do you collect deicing runoff for storage and treatment?  20 Collection technique  21 Estimated collection efficiency (percent of applied glycol)	0.18 650,000 88.00% 572,000 10,800
7 BOD5 concentration of propylene glycol (mg/L) 8 Percent glycol in purchased product 9 BOD5 concentration in the purchased product (mg/L) 10 98-hour aquatic toxicity (LC50) for fathead minnows (mg/L) 11 48-hour aquatic toxicity (LC50) for daphnia (mg/L) 11 48-hour aquatic toxicity (LC50) for daphnia (mg/L) 12 Aquatic toxicity (LC50) for other organisms (mg/L) 13 Name of other test organisms 13 Anne of other test organisms 14 Annual volume of applied aircraft deicer mixture (gallons at working concentration) 15 Maximum daily volume of applied aircraft deicer mixture (gallons at working concentration) 16 Typical application strength of purchased deicer (100% – no dilution of purchased product) 16 To accludated annual volume of aircraft deicer at purchased concentration (gallons) 17 Calculated annual volume of aircraft deicer at purchased concentration (gallons) 18 Deicer Collection and Storage 19 Do you collect deicing runoff for storage and treatment? 20 Collection technique 21 Estimated collection efficiency (percent of applied glycol) 21	650,000 88.00% 572,000 10,800
8 Percent glycol in purchased product 9 BODS concentration in the purchased product (mg/L) 10 96-hour aquatic toxicity (LC50) for fathead minnows (mg/L) 11 48-hour aquatic toxicity (LC50) for fathead minnows (mg/L) 11 48-hour aquatic toxicity (LC50) for daphnia (mg/L) 11 2 Aquatic toxicity (LC50) for other organisms (mg/L) 13 Name of other test organism 14 Annual volume of applied aircraft deicer mixture (gallons at working concentration) 15 Maximum daily volume of applied aircraft deicer mixture (gallons at working concentration) 16 Typical application strength of purchased deicer (100% = no dilution of purchased product) 17 Calculated annual volume of aircraft deicer at purchased concentration (gallons) 18 Cost of aircraft deicer at purchased concentration (gallon) 19 Do you collect deicing runoff for storage and treatment? 20 Collection technique 21 Estimated collection efficiency (percent of applied glycol) 21	88.00% 572,000 10,800
9 BOD5 concentration in the purchased product (mg/L) 10 96-hour aquatic toxicity (LC50) for fathead minnows (mg/L) 11 48-hour aquatic toxicity (LC50) for fathead minnows (mg/L) 12 Aquatic toxicity (LC50) for daphnia (mg/L) 13 Name of other test organisms (mg/L) 14 Annual volume of applied aircraft deicer mixture (gallons at working concentration) 14 Annual volume of applied aircraft deicer mixture (gallons at working concentration) 15 Maximum daily volume of applied aircraft deicer mixture (gallons at working concentration) 16 Typical application strength of purchased deicer (100% = no dilution of purchased product) 16 Typical application strength of purchased deicer (100% = no dilution of purchased product) 17 Calculated annual volume of aircraft deicer at purchased concentration (gallons) 18 Cost of aircraft deicer at purchased concentration (sigallon) 19 Deicer Collection and Storage 19 Do you collect deicing runoff for storage and treatment? 20 Collection technique 21 Estimated collection efficiency (percent of applied glycol) 21	572,000 10,800
10 96-hour aquatic toxicity (LC50) for fathead minnows (mg/L) 11 48-hour aquatic toxicity (LC50) for daphnia (mg/L) 12 Aquatic toxicity (LC50) for other organisms (mg/L) 13 Name of other test organism 13 314 Annual volume of applied aircraft deicer mixture (gallons at working concentration) 14 15 Maximum daily volume of applied aircraft deicer mixture (gallons at working concentration) 15 Typical application strength of purchased deicer (100% – no dilution of purchased product) 16 Totalculated annual volume of aircraft deicer at purchased concentration (gallons) 17 Calculated annual volume of aircraft deicer (100% – no dilution of purchased product) 18 Cost of aircraft deicer at purchased concentration (signallon) 18 Deicer Collection and Storage 19 Do you collect deicing runoff for storage and treatment? 19 Do you collect deicing runoff for storage and treatment? 20 Collection technique 21 Estimated collection efficiency (percent of applied glycol)	10,800
11 48-hour aquatic toxicity (LC50) for daphnia (mg/L) 12 Aquatic toxicity (LC50) for daphnia (mg/L) 12 Aquatic toxicity (LC50) for other organisms (mg/L) 13 Name of other test organism 13 Annual volume of applied aircraft deicer mixture (gallons at working concentration) 14 Annual volume of applied aircraft deicer mixture (gallons at working concentration) 15 Maximum daily volume of applied aircraft deicer mixture (gallons at working concentration) 16 17 Calculated annual volume of aircraft deicer at purchased concentration (gallons) 17 18 Cost of aircraft deicer at purchased concentration (Sigallon) 18 Deicer Collection and Storage 19 Do you collect deicing runoff for storage and treatment? 19 20 Collection technique 20 21 Estimated collection efficiency (percent of applied glycol) 21	
12 Aquatic toxicity (LC50) for other organisms (mg/L)  13 Name of other test organism  14 Annual volume of applied aircraft deicer mixture (gallons at working concentration)  15 Maximum daily volume of applied aircraft deicer mixture (gallons at working concentration)  16 Typical application strength of purchased deicer (100% = no dilution of purchased product)  17 Calculated annual volume of aircraft deicer at purchased concentration (gallons)  18 Cost of aircraft deicer at purchased concentration (sigallon)  19 Do you collect deicing runoff for storage and treatment?  20 Collection technique  21 Estimated collection efficiency (percent of applied glycol)	14,000
13 Name of other test organism 14 Annual volume of applied aircraft deicer mixture (gallons at working concentration) 14 In Maximum daily volume of applied aircraft deicer mixture (gallons at working concentration) 15 Maximum daily volume of applied aircraft deicer mixture (gallons at working concentration) 16 To Spical application strength of purchased deicer (100% – no dilution of purchased product) 17 Calculated annual volume of aircraft deicer at purchased concentration (gallons) 18 Cost of aircraft deicer at purchased concentration (sigallon) 18 Deicer Collection and Storage 19 Do you collect deicing runoff for storage and treatment? 19 Do you collect deicing runoff for storage and treatment? 20 Collection technique 21 Estimated collection efficiency (percent of applied glycol) 21	11,000
14 Annual volume of applied aircraft deicer mixture (gallons at working concentration) 15 Maximum daily volume of applied aircraft deicer mixture (gallons at working concentration) 15 Typical application strength of purchased deicer (100% – no dilution of purchased product) 16 Typical application strength of purchased deicer (100% – no dilution of purchased product) 17 Calculated annual volume of aircraft deicer at purchased concentration (gallons) 18 Cost of aircraft deicer at purchased concentration (Sigallon) 18 Deicer Collection and Storage 19 Do you collect deicing runoff for storage and treatment? 20 Collection technique 21 Estimated collection efficiency (percent of applied glycol) 21	Test
15 Maximum daily volume of applied aircraft deicer mixture (gallons at working concentration)   15   16 Typical application strength of purchased deicer (100% = no dilution of purchased product)   16   17 Calculated annual volume of aircraft deicer at purchased concentration (gallons)   17   18 Cost of aircraft deicer at purchased concentration (gallons)   18   18   19   19   19   19   19   19	51,400
17 Calculated annual volume of aircraft deicer at purchased concentration (gallons) 18 18 Cost of aircraft deicer at purchased concentration (\$\frac{1}{2}\text{igl}(ann)) 18  Deicer Collection and Storage  19 19 Do you collect deicing runoff for storage and treatment? 19 20 Collection technique 20 21 Estimated collection efficiency (percent of applied glycol) 21	18,500
18 Cost of aircraft deicer at purchased concentration (\$Igallon)         18           Deicer Collection and Storage         19           19 Do you collect deicing runoff for storage and treatment?         19           20 Collection technique         20           21 Estimated collection efficiency (percent of applied glycol)         21	50%
Deicer Collection and Storage         19 Do you collect deicing runoff for storage and treatment?         19           20 Collection technique         20           21 Estimated collection efficiency (percent of applied glycol)         21	25,700
19 Do you collect deicing runoff for storage and treatment?         19           20 Collection technique         20           21 Estimated collection efficiency (percent of applied glycol)         21	\$8.63
20 Collection technique     20       21 Estimated collection efficiency (percent of applied glycol)     21	
21 Estimated collection efficiency (percent of applied glycol) 21	€ YES € NO
	Designated deicer pads (50-70%)
	50% 30%
Treatment Information	Flow BOD5 COD
23 Maximum daily amount accepted for treatment 23	25000 2500
24 Units 24	GPM LB/D N/A
25 Unit cost 25	0.0059 \$0.23
Tools and Models  26 Have other water quality tools or models been applied to your site?  26	© YES C NO
KNOWN PROBLEMS	
Exceedances of Permit Limits	
27 Do you periodically exceed your concentration limits for BOD5 or COD?	C YES C NO
28 If so, what is the highest observed daily concentration? (mg/L) 28	140
29 Do you exceed daily load limits for BOD5 or COD?	C YES € NO
	BOD5 COD
30 If so, what is the highest observed daily load? (lbs/day)  Other Known Brohleme	700
Other Known Problems 31 Are there known negative environmental consequences of deicing discharges?  31	
Description of the negative environmental consequence (optional) reduced oxygen levels; invertebrate (due to low oxygen)	€ YES € NO
Treatment legues	C YES C NO
Treatment Issues  32 Are costs of treatment for collected deicer fluid excessive?  32	C YES C NO
33 Is existing treatment and onsite storage capacity adequate for needs?	CYES CNO

Figure 3. Bangor ANG Evaluation

These figures are screen captures of the working decision support tool that may be difficult to read at this size printed out or on a computer screen. Larger-size copies of these figures are included in Attachment 2 for printing on tabloid (11"x17") paper; users may elect to open the accompanying spreadsheet, Evaluation Worksheet BGR.xls, to better view the decision support tool inputs on a computer screen.

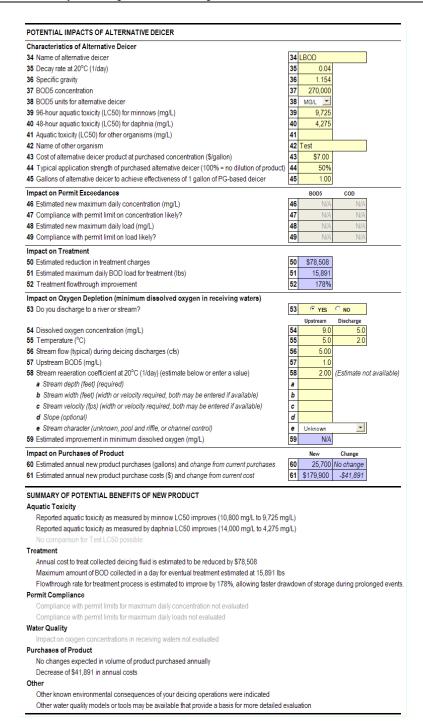


Figure 3. Bangor ANG Evaluation (continued)

These figures are screen captures of the working decision support tool that may be difficult to read at this size printed out or on a computer screen. Larger-size copies of these figures are included in Attachment 2 for printing on tabloid (11"x17") paper; users may elect to open the accompanying spreadsheet, Evaluation Worksheet BGR.xls, to better view the decision support tool inputs on a computer screen.

#### 3.1.3 Portland International Airport (PDX)

Portland International Airport is a medium-sized commercial hub airport serving passenger, cargo, and military flight operations. PDX differs significantly from PIT and BGR in that more deicing activity occurs there than at the Air National Guard bases. The potential environmental impacts of deicing are a significant concern to the airport because all stormwater discharges go to the Columbia Slough, a small, impaired water body that is the subject of a Total Maximum Daily Load for, among other things, dissolved oxygen.

Data from previous investigations at Portland International Airport (PDX) were available to support evaluation of the Decision Support Tool. LimnoTech and CH2M-HILL previously developed highly detailed airfield storm water and receiving models for PDX, along with extensive deicer usage and discharge datasets. Daily ADF usage and storm water and sanitary sewer discharge information and data from the 1995-96 through 2003-04 seasons were used to develop estimates of average annual and maximum daily ADF usage rates, collection efficiency, and discharge/disposal costs for the Decision Support Tool.

The Decision Support Tool configured for PDX is shown in Figure 4. The following highlights of the analysis summarize the case study findings:

- The evaluation of implications for permit compliance issues indicates that reductions in storm water discharge maximum BOD<sub>5</sub> concentrations from approximately 140 mg/L to 50 mg/L and the change in the maximum daily BOD<sub>5</sub> load to approximately 200 pounds are likely to ensure future compliance.
- The following benefits are indicated for the theoretical replacement of conventional PG-based ADF product with one having characteristics similar to LBOD ADF:
  - A reduction in treatment costs for collected runoff of approximately \$59,000 and an increase in the flow through rate of the collection system by approximately 180%.
  - o Reduced aquatic toxicity in deicing discharges.
  - Savings of approximately \$34,000 in annual costs due to the decreased unit cost of the alternative ADF product.
- The Decision Support Tool notes that other known environmental consequences were indicated and suggests that other more sophisticated water quality models or tools may be appropriate to provide a more detailed analysis.

EVALUATION WORKSHEET FOR ALTERNATIVE AIRCRAFT DEICERS	
This evaluation tool was designed to assist a Base Environmental Manager (EM) in assessing the	he likely environmental, regulatory
compliance, and cost implications of a new Type I ADF formulation that is being considered as a	an alternative to the Type I ADF curren
in use. The evaluation is at a screening level, intended to give the EM a sound indication of the	general direction and magnitude of
changes and benefits that can be expected with a switch to the alternative ADF. This information	is intended to support decisions
regarding a switch to the new formulation.	
It is essential to understand that the tool is not intended to replace more sophisticated analyses	that may be required to support
demonstrations of regulatory compliance or engineering design of deicing runoff management s	
	systems.
SITE INFORMATION	
Site Name Portland International Airport	
Address	
Person filling out form	
E-mail Address	Telephone Number
CURRENT SITUATION	
NPDES Storm Water Permit Information	4 6
1 Does your site have an NPDES Storm Water permit for discharge of deicing runoff?	1 • YES • NO
2 NPDES permit number	2
3 Permitting authority	3
Permit limits during periods of peak deicing activity	BOD5 COD
4 Most stringent permitted discharge concentration (mg/L). Leave blank if there are no limits.	4 100
5 Most stringent permitted maximum daily load (lbs/day). Leave blank if there are no limits.	5 1000
Current Type I Deicer Information (See MSDS and manufacturer's literature)	Туре I
6 Decay rate at 20°C (1/day)	6 0.18
7 BOD5 concentration of propylene glycol (mg/L)	7 650,000
8 Percent glycol in purchased product	8 88.00%
9 BOD5 concentration in the purchased product (mg/L)	9 572,000
10 96-hour aquatic toxicity (LC50) for fathead minnows (mg/L)	10 10,800
11 48-hour aquatic toxicity (LC50) for daphnia (mg/L)	11 14,000
12 Aquatic toxicity (LC50) for other organisms (mg/L)	12
13 Name of other test organism	13 Test
14 Annual volume of applied aircraft deicer mixture (gallons at working concentration)	14 42,000
15 Maximum daily volume of applied aircraft deicer mixture (gallons at working concentration)	15 20,700
16 Typical application strength of purchased deicer (100% = no dilution of purchased product)	16 50%
17 Calculated annual volume of aircraft deicer at purchased concentration (gallons)	17 21,000
18 Cost of aircraft deicer at purchased concentration (\$/gallon)	18 \$8.63
Deicer Collection and Storage	
19 Do you collect deicing runoff for storage and treatment?	19 FYES C NO
20 Collection technique	20 Apron drainage diversion (20-50%)
21 Estimated collection efficiency (percent of applied glycol)	21 46%
22 Estimated losses of uncollected deicer fluid (percent of applied glycol)	22 30%
Treatment Information	Flow BOD5 COD
23 Maximum daily amount accepted for treatment	23 0.2 1200
24 Units	24 CFS LB/D N/A
25 Unit cost	25 0.0059 \$0.25
Tools and Models  26 Have other water quality tools or models been applied to your site?	26 YES C NO
KNOWN PROBLEMS	
Exceedances of Permit Limits	
27 Do you periodically exceed your concentration limits for BOD5 or COD?	27 PODS COD
28 If so, what is the highest observed daily concentration? (mg/L)	BOD5 COD 28 140
29 Do you exceed daily load limits for BOD5 or COD?	29 YES NO
30 If so, what is the highest observed daily load? (lbs/day)	BOD5 COD 30 600
Other Known Problems	
31 Are there known negative environmental consequences of deicing discharges?	31 C YES C NO
Description of the negative environmental consequence (optional)	31 31L3 3 NO
Treatment Issues	20 6
32 Are costs of treatment for collected deicer fluid excessive?	32 C YES © NO 33 © YES © NO
33 Is existing treatment and onsite storage capacity adequate for needs?	33 • YES • NO

**Figure 4. PDX Evaluation** 

These figures are screen captures of the working decision support tool that may be difficult to read at this size printed out or on a computer screen. Larger-size copies of these figures are included in Attachment 2 for printing on tabloid (11"x17") paper; users may elect to open the accompanying spreadsheet, Evaluation Worksheet PDX.xls, to better view the decision support tool inputs on a computer screen.

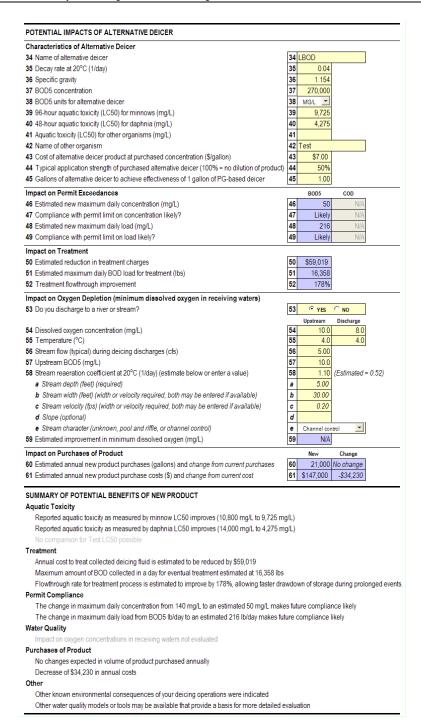


Figure 4. PDX Evaluation (continued)

These figures are screen captures of the working decision support tool that may be difficult to read at this size printed out or on a computer screen. Larger-size copies of these figures are included in Attachment 2 for printing on tabloid (11"x17") paper; users may elect to open the accompanying spreadsheet, Evaluation Worksheet PDX.xls, to better view the decision support tool inputs on a computer screen.

As noted above, there has been a significant amount of work done at PDX on the subject of deicing, including development of an existing detailed airfield loading and deicing discharge model for the facility. This model includes not only predictions of deicer usage as a function of weather, but also the fate and transport of deicing runoff through the airport's deicing runoff management system. The system consists of a series of diversion valves that route deicing runoff to three different destinations depending on deicer concentration: 1) concentrated storage tank (CST) where high-BOD runoff is held for discharge to a POTW; 2) dilute detention basin (DDB) where medium strength deicing runoff is held to be metered into the receiving water in accordance with the airport's NPDES permit daily load limits; and 3) direct discharge to the receiving waters. The complexity of this system was not, of course, represented in the Decision Support Tool depiction of PDX.

The PDX airfield loading model provided the opportunity to conduct an separate evaluation of the implications of switching from a conventional PG-based ADF product to an alternative product. The model was configured to reflect the current deicing runoff management system at PDX and a switch to an ADF having characteristics similar to LBOD ADF. The results were compared to the output of the Decision Support Tool.

**Table 1. PDX Airfield Model Results** 

Scenario	ADF BOD (mg/L)	ADF Factor	Storage (CST and DDB)	Overflow events	Total Overflow Volume	Total BOD mass (tons)
Baseline configu	uration - Standard	1 ADF				
	570,000	1.46	2 MG + 12 MG	83	1,412 MG	2,184
Baseline configu	uration - New AD	F				
	320,000	0.82	2 MG + 12 MG	57	1,082 MG	1,425
Standard ADF +	Added Storage to	o match event	ts (+10.5 MG)			
	570,000	1.46	4 MG + 20.5 MG	57	1.050 MG	1.814
	,	2			_,	_,

The PDX airfield model was run under a typical winter season scenario to assess the impacts of changing the type of ADF used at the facility. Results from analysis of three different scenarios are shown in Table 1, as can be summarized as follows:

Baseline configuration: The PDX airfield model was applied with the current storage configuration of 2 MG in the Concentrated Storage Tank (CST) and 12 MG in the Dilute Detention Basin (DDB), and standard aircraft deicing fluid with a BOD concentration of 570,000 mg/L. The ADF factor, which adjusts ADF usage in terms of BOD, was set to 1.46 to reflect expected growth of 46% over

current traffic. The simulation showed 83 storage overflow events over the 42-year simulation period that could potentially result in permit exceedances.

- New ADF: The model was applied with the same storage configuration, but with the ADF factor set to 0.82 to simulate the reduced BOD concentration of a new ADF formulation. The model indicated that only 57 storage overflow events were expected under the same conditions as for the baseline run.
- Added Storage: Concentrated and dilute storage were increased iteratively until the number of overflow events predicted with current ADF formulations matched the number of events predicted in the "New ADF" scenario. CST storage was increased to 4 MG and DDB storage was increased to 20.5 MG to achieve this match, a total increase of 10.5 MG in on-site storage.

The results of these analyses suggest that use of an alternative ADF could provide a water quality benefit equivalent to adding a total of 10.5 MG of additional storage at PDX.

A comparison of results between the Decision Support Tool and the airfield loading model yields the following observations:

- The evaluation of changes in storage requirements as a function of an alternative ADF is beyond the capabilities of the Decision Support Tool, which does not provide mechanisms for evaluation of storage size needs.
- The Decision Support Tool analysis suggests that permit compliance is likely using the new ADF. Although the detailed airfield model predicts improved compliance, the probability of non-compliance events remains significant. The discrepancy in these results reflects differences in the level of sophistication in the analyses. The PDX deicing runoff control system is both complex in its configuration and dynamic in its operation. The Decision Support Tool simply cannot represent these subtleties in its screening-level portrayal of the system.

#### 3.2 REVIEW AND FEEDBACK

As part of the case studies development, feedback was sought from the airfield and airport representatives on the Decision Support Tool.

The functionality of the tool was judged as acceptable. The representatives indicated that the tool provided a convenient and user friendly means of evaluating general operational implications of a theoretical change in deicing fluid used at their facility. The following specific recommendations were provided for improving the utility of the Decision Support Tool to their situations:

1. A higher level of detailed analysis for evaluating operations at a finer temporal scale. For example, LTC Tower indicated that runoff diversion valves are sometimes managed to provide for the capture of the initial 0.1 inch of runoff (i.e. first flush) and that subsequent runoff may be routed to a different location.

- 2. Capability for including other deicing materials in the analyses and subsequent evaluation of implications for storage and discharge requirements. Both ANG representatives indicated that pavement chemicals can be of concern to their collection and discharge operations and that the ability to include these materials in the analyses would be helpful.
- 3. Include consideration of deicing material storage, shelf life, and delivery/refill implications based on estimated changes in volume of purchased product.
- 4. Instructions were generally characterized as appropriate and helpful. Some of the line item text in the worksheet was changed to reflect clarifying suggestions with respect to terminology, and the instructions were expanded with additional discussions of sources for default data and of temperature impacts on measurements and calculations.

The first three items are not incorporated in this version of the evaluation worksheet. The suggestions are acknowledged as being of value for environmental management personnel at air facilities, but are outside of the objective for this immediate effort, which is to provide a generalized tool that is widely applicable for screening purposes. The additional functionality requested may be considered in any future enhancements that may be considered for the Decision Support Tool.

#### 4. SUMMARY

A Decision Support Tool was developed to provide a means for environmental management personnel to evaluate the implications of changing aircraft deicer fluid from a conventional propylene glycol based product to an alternative product. The tool was configured using data from three facilities, the Bangor ANG facility in Bangor, Maine, the Pittsburgh ANG facility in Pittsburgh, PA, and Portland International Airport, in Portland, Oregon. The data from these facilities is representative of a range of operational sizes and deicing fluid usage rates.

Testing of the Decision Support Tool using data provided by PIT, BNG, and PDX indicated a range of benefits to the facilities realized through a switch from a convention PG-based ADF to an alternative product. Decreased toxicity, treatment costs, and annual purchase costs were predicted for all three facilities. Improved permit compliance was predicted at PDX by the Tool and an independent evaluation using the existing airfield model, although the tool provided a significantly more optimistic projection. This observation emphasizes the fact that the Decision Support Tool results should be understood to be simplified, screening-level predictions.

The tool was reviewed with environmental management personnel at each of the facilities. Feedback on the ease of use and general utility of the tool was positive from all three individuals interviewed. Suggestions for increasing the value of the tool were provided but the implementation of those suggestions was outside the scope of this effort. Specific recommendations included the following:

- Adding provisions for a higher level of detailed analysis would be useful for evaluating operations at a finer temporal scale to allow for the evaluation of operational strategies on storage and discharge characteristics, and
- Additional algorithms to allow for the evaluation of potential influences of pavement deicing materials on storage and discharge requirements.

The review process indicated that the Decision Support Tool, as developed, provides airport environmental personnel with a convenient means for evaluating the implications of changing the type of aircraft deicing fluid used at a facility.

This page is blank to facilitate double sided printing.

#### **ATTACHMENT 1**

**Decision Support Tool Instructions** 

This page is blank to facilitate double sided printing.

#### Instructions

#### **Evaluation Worksheet for Alternative Aircraft Deicers**

#### Overview

The potential environmental impacts of stormwater runoff that contains aircraft deicing chemicals is a serious concern to state and federal environmental regulators. The primary concerns center on elevated biochemical oxygen demand (BOD) in stormwater discharges that may cause reduced dissolved oxygen in the receiving streams, and toxicity to aquatic organisms from additives that are required to meet SAE fluid performance specifications.

Research and product development efforts by the ADF manufacturers, the U.S. Government, and others are resulting in the introduction of reformulated and new aircraft deicing fluids (ADFs) with improved environmental characteristics. These new products are entering the marketplace on a regular basis, with properties that represent potentially significant improvements over older ADF formulations. However, the actual benefits that a new formulation will provide at a base or airport depends on many facility-specific factors. Thus, an evaluation is needed to confirm that the improved environmental characteristics of the product are actually likely to make a difference in the specific operational and regulatory context of the facility.

This evaluation tool was designed to assist a Base Environmental Manager (EM) in assessing the likely environmental, regulatory compliance, and cost implications of a new Type I ADF formulation that is being considered as an alternative to the Type I ADF currently in use. The evaluation is at a screening level, intended to give the EM a sound indication of the general direction and magnitude of changes and benefits that can be expected with a switch to the alternative ADF. This information is intended to support decisions regarding a switch to the new formulation.

It is essential to understand that the tool is not intended to replace more sophisticated analyses that may be required to support demonstrations of regulatory compliance or engineering design of deicing runoff management systems.

The tool has been laid out in a format similar to many IRS forms and therefore should be familiar to most people. The tool is generally self-explanatory, with instructions provided below to ensure that the user has a clear understanding of the information that is required to fill out the tool, and can appropriately interpret the evaluation output. You may save the file under a unique name to archive the analysis, and print out the form for your records.

#### General Instructions

This evaluation worksheet is provided as a Microsoft Excel workbook to be filled out on your computer. All information is to be entered into the boxes shaded yellow. Results calculated from the information you have entered will be displayed in boxes shaded light blue. Certain fixed information, such as the concentration of BOD₅ in 100% propylene glycol, is shown in boxes shaded gray.

Specific instructions are presented below for the different sections of the worksheet.

#### **FACILITY INFORMATION**

This section identifies the site for which an alternative aircraft deicing material or method is being considered, and ensures that the documentation will be complete for the user's files. Please enter information as accurately as possible to ensure that the documentation for your files is complete.

#### **CURRENT SITUATION**

This section describes current practices, aircraft deicers used, and other relevant information about your site.

#### NPDES Storm Water Permit Information

If your facility is operating under a permit that authorizes discharge of deicing runoff, please provide the following information. Note: If you do not hold a permit for stormwater discharges containing deicing materials, and deicing is conducted at your facility, a compliance assessment may be advisable.

Line 1 – Does your site have an NPDES Storm Water permit for discharge of deicing runoff? Mark Yes or No.

Line 2 – NPDES permit number. Enter permit number from your NPDES permit.

Line 3 – Permitting authority. Enter the name of the permitting authority that issues your permit.

Line 4 – Most stringent permitted discharge concentration (mg/L). Enter the most stringent permitted concentration limit applicable during periods of peak deicing. If no limit is specified in the permit, leave the line blank.

Line 5 – Most stringent permitted maximum daily load (lbs/day). Enter the most stringent permitted daily load limit applicable during periods of peak deicing.

#### Current Type I Deicer Information

This subsection describes characteristics of the aircraft deicer fluid currently in use at your site as well as application practices and usage. Product characteristics are often provided in the product material safety data sheet (MSDS) or other manufacturer literature.

Line 6 - BOD<sub>5</sub> Decay rate at 20°C (1/day). This value describes the rate at which biological oxygen demand - associated with the chemicals in the aircraft deicer fluid - is reduced following application. This information is typically not provided for existing deicers, so a default value is provided that is based on FSTCP lab measurements. This default value of 0.18/day can be changed if you have decay rate information specific to your existing purchased aircraft deicer product. The value supplied for 20°C is temperature-corrected for calculations according to standard methods.

Line 7 – BOD₅ concentration of propylene glycol (mg/L). A constant value of 650,000 mg/L has been provided that is representative of industry norms. This default can be changed if you have product-specific information.

Line 8 – Percent glycol in purchased product. Enter the percent propylene glycol in your purchased product as described in the MSDS on the label.

Line 9 – BOD₅ concentration in the purchased product (mg/L). The BOD₅ concentration in your purchased product is calculated from the information in Line 7 and Line 8. The calculated value will change to reflect product-specific information you may enter.

Line 10 – 96-hour aquatic toxicity (LC50) for fathead minnows (mg/L). Enter the concentration reported for your purchased product, if available.

Line 11 – 48-hour aquatic toxicity (LC50) for daphnia (mg/L). Enter the concentration reported for your purchased product, if available.

Line 12 – Aquatic toxicity (LC50) for other organisms (mg/L). Enter the concentration reported for your purchased product, if available.

Line 13 – Name of other organism. If you entered information on Line 12 about aquatic toxicity results for an organism other than fathead minnows or daphnia, enter the name of the organism here.

Line 14 – Annual volume of applied aircraft deicer mixture (gallons at working concentration). Enter annual gallons applied to aircraft at working concentrations (e.g. total gallons sprayed) in a typical or average year.

Line 15 – Maximum daily volume of applied aircraft deicer mixture (gallons at working concentration). Enter the maximum daily total of gallons applied to aircraft at working concentrations (e.g. most gallons sprayed in a day). The maximum daily total should not exceed the typical annual volume in Line 14.

Line 16 – Typical application strength of purchased deicer (100% = no dilution of purchased product). Enter a percentage that reflects the strength at which you apply your purchased deicer. This is NOT the glycol concentration of the deicer! For example, if you purchase pre-mixed deicer at working concentration that is ready for application, enter 100%; if you mix equal parts of purchased concentrated product and water to get working concentration prior to application, enter 50%.

Line 17 – Calculated annual volume of aircraft deicer at purchased concentration (gallons). The typical annual volume purchased is calculated from the information entered in Line 14 and Line 16.

Line 18 – Cost of aircraft deicer at purchased concentration (\$/gallon). Enter the price you pay per gallon for purchased aircraft deicer product.

#### Deicer Collection and Storage

At many airfields, deicing runoff is collected for recycling or treatment.

Line 19 – Do you collect deicing runoff for storage and treatment? If you collect deicing runoff for storage and treatment, mark "Yes". Otherwise, mark "No".

Line 20 – Collection Technique. Select the appropriate collection technique used at your airfield. The techniques included in this entry are presented with a typical range of collection efficiencies for the techniques:

Designated deicing pads: 50 – 70%

Sweeper-vacs: 25 - 35%

Apron drainage diversion during deicing: 20 - 50%

Other: 0% - 100%

Line 21 – Estimated collection efficiency (percent of applied glycol). Enter the average percentage of applied aircraft deicing mixture that is collected for storage and treatment during the deicing season. For example, if you apply deicing fluid that contains a total of 10,000 gallons of glycol, and collect runoff containing 6,500 gallons of glycol for treatment/ disposal during a season, enter 65%. If you do not have facility data on collection, use the guidelines provided under Line 20 to roughly estimate your collection efficiency. The sum of the collection efficiency and the estimated losses in Line 22 should not add up to more than 100%.

Line 22 – Estimated losses of uncollected deicer fluid (percent of applied glycol). A constant loss rate of 30% has been specified to account for deicer fluid that is not collected and does not reach your receiving water (if any).

#### Treatment Information

Treatment may consist of onsite processes or conveyance to an offsite treatment plant.

Line 23 – Maximum daily amount accepted for treatment. Enter any daily limits on flow or mass of BOD5 or COD for your treatment process or offsite conveyance.

Line 24 – Units. Indicate units for the limits, if any, specified in line 23.

Line 25 – Unit cost. Enter the unit cost assessed to you for treatment.

#### Tools and Models

This worksheet provides a screening-level evaluation of operational and environmental impacts from deicing activities. More detailed previous studies, if available, may support more nuanced evaluations or identify other areas of concern.

Line 26 – Have other WQ tools or models been applied to your site? If other water quality assessments have been done, or other water quality models applied for evaluation of impacts of deicing activities at your site, mark "Yes". Otherwise, mark "No".

#### KNOWN PROBLEMS

This section allows you to enter information characterizing some problems that are common to many facilities that deice aircraft. Not all problem areas may be relevant to your site.

#### Exceedances of Permit Limits

Continuing exceedance of load or concentration limits in a discharge permit may lead to fines or other enforcement actions.

Line 27 – Do you periodically exceed your concentration limits for BOD<sub>5</sub> or COD? If your monitoring data for discharge limits shows concentrations above your permit limits, mark "Yes".

Line 28 – If so, what is the highest observed daily concentration? (mg/L). If concentration limits are exceeded, enter the highest observed concentration from your monitoring data.

Line 29 – Do you exceed daily load limits for BOD₅ or COD? If your monitoring data for discharge limits shows loads above your permit limits, mark "Yes".

Line 30 – If so, what is the highest observed daily load? (lbs/day). If load limits are exceeded, enter the highest observed load from your monitoring data.

#### Other Known Problems

This evaluation worksheet addresses only certain common issues. You may have site-specific issues not covered herein.

Line 31 – Are there known negative environmental consequences? Mark "Yes" or "No". Some examples of negative consequences would be fish kills, odor complaints, or growths of attached bacteria at outfalls.

#### Treatment Issues

Treatment issues considered in this worksheet are annual cost of treatment and treatment capacity.

Line 32 – Are costs of treatment for collected deicer fluid excessive? Mark "Yes" if costs associated with treatment of collected aircraft deicer fluid are a burden for your facility.

Line 33 – Is existing treatment and onsite storage capacity adequate for needs? Mark "Yes" if your treatment system and onsite storage capacities are generally sufficient to handle the volume of collected aircraft deicer fluid.

#### POTENTIAL IMPACTS OF ALTERNATIVE DEICER

This is where you describe the properties of the alternative deicer under consideration and develop a screening-level assessment of a potential change to use of the alternative deicer.

#### Characteristics of Alternative Deicer

This section describes the properties of the alternative deicer under consideration.

Line 34 – Name of alternative deicer. Enter name of product under consideration.

Line 35 – BOD $_5$  decay rate at 20°C (1/day). Enter the decay rate reported in product literature.

**Line 36 – Specific gravity.** Enter the specific gravity of the alternative product.

Line 37 – BOD<sub>5</sub> concentration (mg/kg). Enter the BOD<sub>5</sub> concentration reported for the alternative deicer as purchased.

Line 38 – Units for alternative deicer for BOD<sub>5</sub>. Indicate the units used for the concentration reported in Line 37.

Line 39 – 96-hour aquatic toxicity (LC50) for fathead minnows (mg/L). Enter the concentration reported for the alternative deicer named in Line 34.

Line 40 – 48-hour aquatic toxicity (LC50) for daphnia (mg/L). Enter the concentration reported for the alternative deicer named in Line 34.

Line 41 – Aquatic toxicity (LC50) for other organisms (mg/L). Enter the concentration reported for the alternative deicer named in Line 34.

Line 42 – Name of other organism. If you entered information on Line 41 about aquatic toxicity results for an organism other than fathead minnows or daphnia, enter the name of the organism here.

Line 43 - Cost of alternative deicer product at purchased concentration (\$/gallon). Enter the price you will pay per gallon for the alternative deicer product named in Line 34.

Line 44 – Strength of purchased alternative deicer at which you will apply (100% = no dilution of product). Enter a percentage that reflects the strength at which you will apply your alternative deicer. For example, if you will apply the alternative deicer product undiluted, enter 100%; if you mix equal parts of product and water for application, enter 50%.

Line 45 – Gallons of alternative deicer equivalent to effectiveness of 1 gallon PG-based deicer. This line measures the effectiveness of the alternative deicer relative to propylene glycol. For example, if it is necessary to only apply 9 gallons of an alternative deicer mixture to achieve the same result as 10 gallons of a propylene glycol-based mixture, enter 0.9 (9/10).

#### Impact on Permit Exceedances

If permit exceedances were identified as a known problem at your site, this worksheet estimates new discharge concentrations and loads based on the alternative deicer characteristics.

Line 46 – Estimated new maximum daily concentration (mg/L). If applicable, the worksheet estimates a maximum discharge concentration using alternative deicer.

Line 47 – Compliance with permit limit on concentration likely? If applicable, the worksheet presents a qualitative assessment of the likelihood of compliance with reported permit limits. If the new estimated concentration from Line 46 is greater than the permit limit reported in Line 4, compliance is reported as "Not Likely". If the new concentration is 20% or more lower than the permit limit, compliance is reported as "Likely". Otherwise, compliance is "Possible".

Line 48 – Estimated new maximum daily load (mg/L). If applicable, the worksheet estimates a maximum discharge load using the alternative deicer.

Line 49 – Compliance with permit limit on load likely? If applicable, the worksheet presents a qualitative assessment of the likelihood of compliance with reported permit limits. If the new estimated load from Line 48 is greater than the permit limit reported in Line 5, compliance is reported as "Not Likely". If the new load is 20% or more lower than the permit limit, compliance is reported as "Likely". Otherwise, compliance is "Possible".

#### Impact on Treatment

If treatment costs or loads were identified as areas of concerns, the worksheet will provide simple estimates of potential changes in treatment costs and operations.

Line 50 – Estimated reduction in treatment charges. If applicable, the worksheet presents the estimated reduction in costs for treatment of collected aircraft deicing fluid.

Line 51 – Estimated maximum daily BOD₅ load for treatment (lbs). If applicable, the worksheet presents the estimated new maximum daily BOD₅ load for conveyance to treatment.

Line 52 – Treatment flowthrough improvement. If applicable, the worksheet presents an estimate of potential improvement in treatment process rates and volumes. This estimate assumes that the treatment process is mass-limited, and that a reduction in BOD5 content of collected aircraft deicing fluid therefore may allow quicker treatment and therefore faster drawdown of storage. A ratio of 200% would indicate that treatment could occur twice as fast and that therefore twice as much volume could be processed in the same time.

#### Impact on Oxygen Depletion (minimum dissolved oxygen in receiving waters)

For sites where deicing fluid reaches a river or stream as stormwater runoff, the worksheet can perform a simple estimate of dissolved oxygen dynamics in the receiving water. The worksheet looks at a critical condition corresponding to your maximum daily usage as reported in Line 15 and compares the resultant minimum dissolved oxygen levels in the receiving waters.

Line 53 – Do you discharge to a river or stream? Mark "Yes" only if deicing fluids from your site are discharges to a free-flowing stream or river. Discharges to lakes and estuaries are not evaluated in this worksheet.

Line 54 - Dissolved oxygen concentration (mg/L). Enter measured or estimated dissolved oxygen levels in the discharged stormwater and in the stream above the point of discharge. If sitespecific data are not available, use 9.0 mg/L for upstream and 5.0 mg/L for discharge concentration.

Line 55 - Temperature (°C). Enter measured or estimated temperature in the discharged stormwater and in the stream above the point of discharge. If site-specific data are not available, use 9.0° for upstream and 5.0° for discharge temperature.

Line 56 - Stream flow (cfs). Enter measured or estimated streamflow above the point of discharge. Measured streamflow may be available from the U.S. Geological Survey (www.waterdata.usgs.gov); other estimation methods are discussed online (e.g. http://www.geog.umb.edu/wdripps/Fieldmethods/streamflow.doc).

Line 57 – Upstream  $BOD_5$  (mg/L). Enter measured or estimated  $BOD_5$  above the point of discharge. If sitespecific data are not available, use 1.0 mg/L for upstream  $BOD_5$ 

Line 58 – Stream reaeration coefficient at 20°C (1/day). Supply your own estimated value, or enter information about your stream in Lines 58a-e for the worksheet to calculate a reaeration coefficient.

Line 59 - Estimated improvement in minimum dissolved oxvaen (mg/L). The worksheet calculates how much oxygen depletion (minimum instream dissolved oxygen) changes in this simple evaluation when the alternative aircraft deicer is used. A positive result is an improvement in oxygen concentrations; for example, a result of 4.5 mg/L means that the maximum amount of oxygen depletion was 4.5 mg/L less for the alternative product, and that minimum oxygen concentrations in the stream or river are therefore expected to be 4.5 mg/L higher.

There are a number of equations that can be used to estimate stream reaeration coefficients from more directly measureable characteristics such as flow depth and velocity. Some use more parameters than others, to achieve more reliable estimates. Further, these equations generally only apply to certain ranges of stream characteristics, that sometimes overlap. The worksheet uses all available information and chooses the most appropriate equation.

Line 58a – Stream depth. Enter the depth of the stream in feet. Stream depth is required.

Line 58b – Stream width. Enter the width of the stream in feet, if available. You must enter either the stream width or the stream velocity to get an estimate. Enter both if available to refine the estimate.

Line 58c – Stream velocity (fps). Enter the velocity of the stream in feet, if available. You must enter either the stream width or the stream velocity to get an estimate. Enter both parameters if available to refine the estimate.

Line 58d – Slope (optional). Enter the bottom slope of the stream if available to refine the estimate. Line 58e – Stream character (unknown, pool and riffle, or channel control). If feasible, indicate if the stream is characterized by pools and riffles or instead is channel controlled (with uniform, often engineered, crosssections).

#### Impact on Purchases of Product

Differences in strength or effectiveness of the alternative product may result in changes in purchase costs and amounts.

Line 60 - Estimated annual new product purchases (gallons) and change from current purchases. The worksheet estimates annual purchases of the alternative (new) deicer from your current usage by applying application dilution information and relative effectiveness. The estimated new purchase amount and the change in volume from the current purchase amount are both shown.

Line 61 - Estimated annual new product purchase costs (\$) and change from current costs. The worksheet estimates annual purchase costs of the alternative (new) deicer by applying the cost information you have provided in Line 18 and Line 42 to the annual purchase volumes estimated in Line 17 and Line 59. The estimated new purchase cost and the change from the current purchase cost are both shown.

#### **SUMMARY**

The Summary section presents brief qualitative assessments of potential impacts related to the use of the alternative deicer fluid compared to conventional Type I ADF. Assessments are presented by the following categories of potential impact or change:

Aquatic Toxicity – The change in the toxicity of Type I deicer to test organisms for which LC50s have been entered. An increased LC50 number represents decreased toxicity.

Treatment – Assessments of the implications to the treatment of collected deicing runoff. Aspects include how quickly collected runoff can be discharged to treatment, and cost of treatment.

Permit Compliance – Provides an assessment of the likelihood of permit compliance with concentration and/or load limits.

Water Quality – Assesses likely impacts on dissolved oxygen in the receiving stream based on the simple spreadsheet analysis.

Purchases of Product – Assesses likely implications to cost of purchased deicer.

Other – Provides comments on the presence of additional issues, and additional modeling analyses that may be worth conducting.

#### ATTACHMENT 2

**Additional Figures** 

This page is blank to facilitate double sided printing.

일 일

© YES

33 33

33 Is existing treatment and onsite storage capacity adequate for needs?

POTENTIAL IMPACTS OF ALTERNATIVE DEICER

32 Are costs of treatment for collected deicer fluid excessive?

Treatment Issues

ջ

YES

34

31 Are there known negative environmental consequences of deicing discharges?

Description of the negative enviro

#### The evaluation is at a screening level, intended to give the EM a sound indication of the general direction and magnitude of ice, and cost implications of a new Type I ADF formulation that is being considered as an alternative to the Type I ADF cun This evaluation tool was designed to assist a Base Environmental Manager (EM) in assessing the likely environmental, regulatory changes and benefits that can be expected with a switch to the alternative ADF. This information is intended to support decisions It is essential to understand that the tool is not intended to replace more sophisticated analyses that may be required to support 000 000 8 9 2 8 LB/D 용 9 © YES · YES YES · YES 8 **BOD5** B0D5 8005 4 6 2 2 2 26 8 22 24 25 27 8 8 16 Typical application strength of purchased deicer (100% = no dilution of purchased product) 17 Calculated annual volume of aircraft deicer at purchased concentration (gallons) 15 Maximum daily volume of applied aircraft deicer mixture (gallons at working concentration) 4 Most stringent permitted discharge concentration (mg/L). Leave blank if there are no limits 5 Most stringent permitted maximum daily load (lbs/day). Leave blank if there are no limits. permit for discharge of deicing runoff? 14 Annual volume of applied aircraft deicer mixture (gallons at working concentration) design of deicing runoff mar Current Type I Deicer Information (See MSDS and manufacturer's literature) **EVALUATION WORKSHEET FOR ALTERNATIVE AIRCRAFT DEICERS** 27 Do you periodically exceed your concentration limits for BOD5 or COD? cted deicer fluid (percent of applied glycol) quality tools or models been applied to your site? 18 Cost of aircraft deicer at purchased concentration (\$lgallon) 10 96-hour aquatic toxicity (LC50) for fathead minnows (mg/L) 19 Do you collect deicing runoff for storage and treatment? 20 Collection technique 21 Estimated collection efficiency (percent of applied glycol) 22 Estimated losses of uncollected deicer fluid (percent of ap Permit limits during periods of peak deicing activity 30 If so, what is the highest observed daily load? (lbs/day) 9 BOD5 concentration in the purchased product (mg/L) 11 48-hour aquatic toxicity (LC50) for daphnia (mg/L)12 Aquatic toxicity (LC50) for other organisms (mg/L)13 Name of other test organism Do you exceed daily load limits for BOD5 or COD? BOD5 concentration of propylene glycol (mg/L) 23 Maximum daily amount accepted for treatment compliance or engi NPDES Storm Water Permit Information 1 Does vour site have an NPDES Storm Water If so, what is the highest observed daily regarding a switch to the new formulation. 8 Percent glycol in purchased product Deicer Collection and Storage Exceedances of Permit Limits 6 Decay rate at 20°C (1/day) 2 NPDES permit number Other Known Problems Treatment Information **CURRENT SITUATION** KNOWN PROBLEMS SITE INFORMATION 26 Have other water Tools and Models Permitting auth rson filling out form 25 Unit cost 24 Units ite Name 88 23

Figure 1. Evaluation Worksheet for Alternative Deicer Fluids

Other water quality models or tools may be available that provide a basis for more detailed evaluation

Other known environmental consequences of your deicing operations were indicated

Other

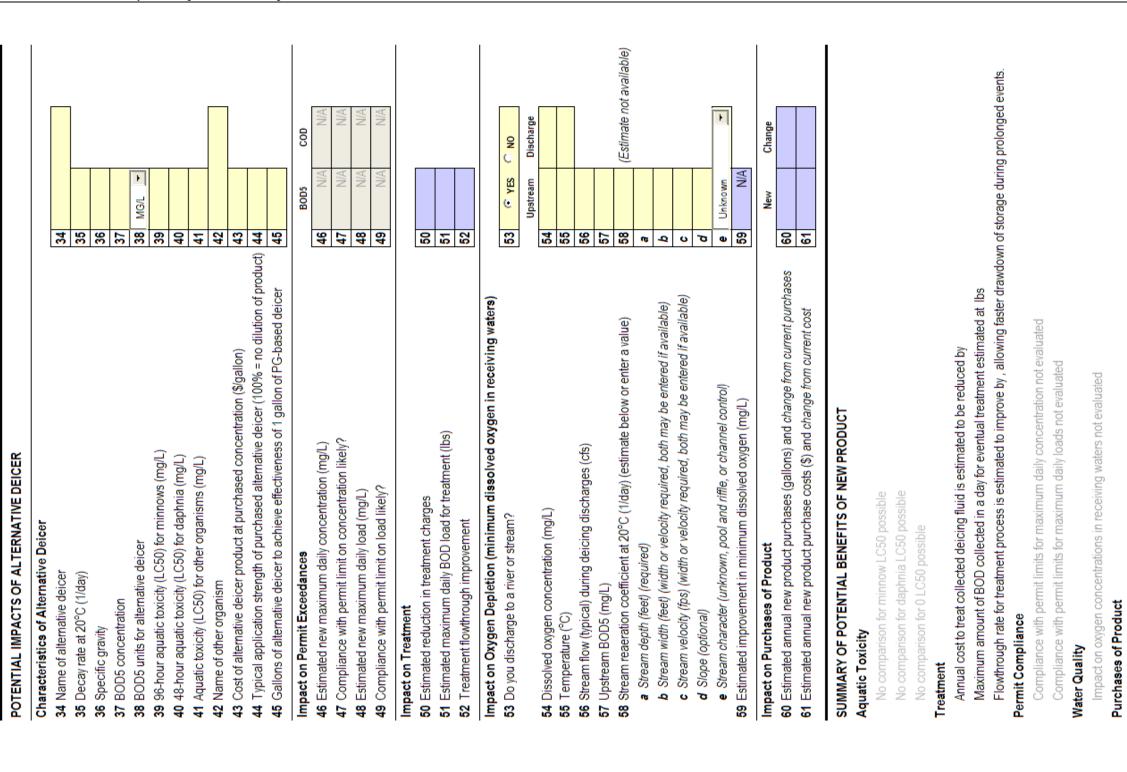


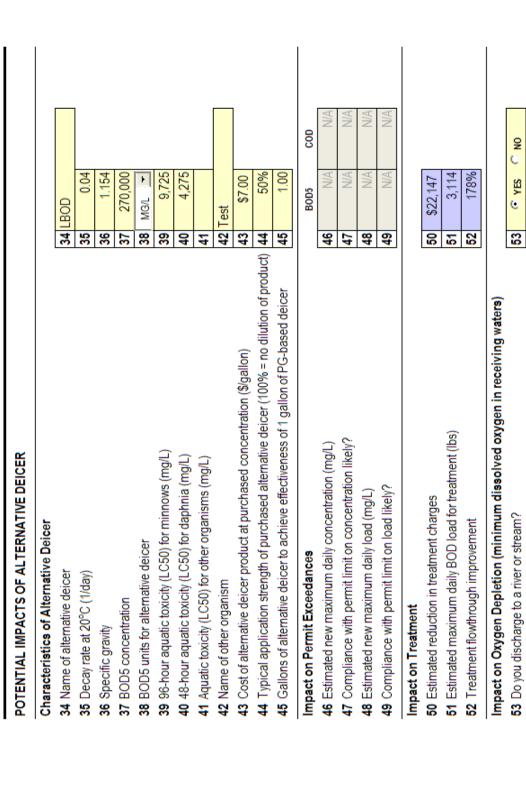
Figure 1. Evaluation Worksheet for Alternative Deicer Fluids (continued)

POTENTIAL IMPACTS OF ALTERNATIVE DEICER

# LUATION WORKSHEET FOR ALTERNATIVE AIRCRAFT DEICERS

This evaluation tool was designed to assist a Base Environmental Manager (EM) in assessing the likely environmental, regulatory compliance, and cost implications of a new Type I ADF formulation that is being considered as an alternative to the Type I ADF currently	e likely environmental, regulatory n alternative to the Type I ADF currently
in use. The evaluation is at a screening level, interiord to give the Em a sound malcation of the general direction and magnitude of changes and benefits that can be expected with a switch to the alternative ADF. This information is intended to support decisions regarding a switch to the new formulation.	ferierar direction and magnitude or is intended to support decisions
It is essential to understand that the tool is not intended to replace more sophisticated analyses that may demonstrations of regulatory compliance or engineering design of deicing runoff management systems.	hat may be required to support ystems.
SITEINFORMATION	
Site Name Pittsburgh ANG	
Address	
Person filing out form Chris Cieciek, LimnoTech on behalf of LTC John Towers	
E-mail Address crieciek@linno.com	Telephone Number
CURRENT SITUATION	
NPDES Storm Water Permit Information 1 Does your site have an NPDES Storm Water permit for discharge of deicing runoff?	1 © YES C NO
2 NPDES permit number 3 Permitting authority	
Permit limits during periods of peak deicing activity	B0D5 C0D
4 Most stringent permitted discharge concentration (mg/L). Leave blank if there are no limits. 5 Most stringent permitted maximum daily load (lbs/day). Leave blank if there are no limits.	4 10
Current Type I Deicer Information (See MSDS and manufacturer's literature)	Type1
<ul> <li>Decay rate at ZUTC (1/day)</li> <li>BOD5 concentration of propylene glycol (mg/L)</li> </ul>	0.018
8 Percent glycol in purchased product 9 RODS concentration in the purchased product (moll.)	8 88.00%
11 48-hour aquatic toxicity (LC50) for daphnia (mg/L) 12 Aquatic toxicity (LC50) for other organisms (mg/L)	11 14,000
13 Name of other test organism	Test
14 Annual volume of applied aircraft deicer mixture (gallons at working concentration) 15 Maximum daily volume of applied aircraft deicer mixture (gallons at working concentration)	14     25,000       15     6,250
16 Typical application strength of purchased deicer (100% = no dilution of purchased product) 17 Calculated annual volume of aircraft deicer at purchased concentration (gallons)	
18 Cost of aircraft deicer at purchased concentration (\$/gallon)	
Deicer Collection and Storage 19 Do you collect deicing runoff for storage and treatment?	19 © YES C NO
20 Collection technique	Sweeper vacs (
21 Estimated collection efficiency (percent of applied glycol) 22 Estimated losses of uncollected deicer fluid (percent of applied glycol)	21     29%       22     30%
Treatment Information	Flow BOD5 COD
24 Units 25 Init cost	24 GPM - LB/D - N/A - 35 0.22
Tools and Models	
26 Have other water quality tools or models been applied to your site?	26 C YES © NO
KNOWN PROBLEMS	
Exceedances of Permit Limits 27 Do you periodically exceed your concentration limits for BOD5 or COD?	27 CYES © NO
28 If so, what is the highest observed daily concentration? (mg/L) 29 Do you exceed daily load limits for BOD5 or COD?	40
30 If so, what is the highest observed daily load? (lbs/day)	30 700 cob
Other Known Problems	0 !!! 0
Description of the negative environmental consequence (optional)	ON STEE NO
Treatment Issues	
32 Are costs of treatment for collected deicer fluid excessive? 33 Is existing treatment and onsite storage capacity adequate for needs?	32 CYES © NO 33 © YES © NO

Figure 2. Pittsburgh ANG Evaluation



## 12,500 No change \$87,500 -\$20,375 Change 61 60 Estimated annual new product purchases (gallons) and change from current purchases 61 Estimated annual new product purchase costs (\$) and change from current cost Stream character (unknown, pool and riffle, or channel control) 59 Estimated improvement in minimum dissolved oxygen (mg/L) Impact on Purchases of Product

## SUMMARY OF POTENTIAL BENEFITS OF NEW PRODUCT

## Aquatic Toxicity

Reported aquatic toxicity as measured by daphnia LC50 improves (14,000 mg/L to 4,275 mg/L)

Reported aquatic toxicity as measured by minnow LC50 improves (10,800 mg/L to 9,725 mg/L)

### Treatment

Annual cost to treat collected deicing fluid is estimated to be reduced by \$22,147

allowing faster drawdown of storage during prolonged events Maximum amount of BOD collected in a day for eventual treatment estimated at 3,114 lbs is estimated to improve by 178%, Flowthrough rate for treatment process

ce with permit limits for maximum daily concentration not ev with permit limits for maximum daily loads not eval

Permit Compliance

Water Quality

No changes expected in volume of product purchased annually Decrease of \$20,375 in annual costs

Purchases of Product

#### Other

#### Figure 2. Pittsburgh ANG Evaluation (continued)

d Slope (optional)

Stream velocity (fps) (width or velocity required, both may be entered if available) Stream width (feet) (width or velocity required, both may be entered if available)

Stream reaeration coefficient at 20°C (1/day) (estimate below or enter a value)

Stream depth (feet) (required)

9

56 Stream flow (typical) during deicing discharges (cfs) 57 Upstream BOD5 (mg/L) 58 Stream reaeration coefficient at 20°C (1/day) (estima

54 Dissolved oxygen concentration (mg/L) 55 Temperature (°C)

(Estimate not available)

5.00

ON O

© YES

33

33 Is existing treatment and onsite storage capacity adequate for needs?

POTENTIAL IMPACTS OF ALTERNATIVE DEICER

32 Are costs of treatment for collected deicer fluid excessive?

Treatment Issues

reduced oxygen levels; invertebrate (due to low oxygen)

of the neg

#### nce, and cost implications of a new Type I ADF formulation that is being considered as an alternative to the Type I ADF curr evaluation is at a screening level, intended to give the EM a sound indication of the general direction and magnitude of This evaluation tool was designed to assist a Base Environmental Manager (EM) in assessing the likely environmental, regulatory changes and benefits that can be expected with a switch to the alternative ADF. This information is intended to support decisions It is essential to understand that the tool is not intended to replace more sophisticated analyses that may be required to support \$0.23 8 COD LB/D 9 일 9 ş 00 50% 25,700 \$8.63 14,000 51,400 18,500 572,000 · YES YES YES BOD5 B0D5 11 12 14 15 17 18 4 5 22 23 26 27 23 28 8 31 9 7 8 6 10 19 20 21 22 16 Typical application strength of purchased deicer (100% = no dilution of purchased product) 17 Calculated annual volume of aircraft deicer at purchased concentration (gallons) 18 Cost of aircraft deicer at purchased concentration (\$\mathbb{S}\)gallon) 14 Annual volume of applied aircraft deicer mixture (gallons at working concentration) 15 Maximum daily volume of applied aircraft deicer mixture (gallons at working concentration) 4 Most stringent permitted discharge concentration (mg/L). Leave blank if there are no limits 5 Most stringent permitted maximum daily load (lbs/day). Leave blank if there are no limits. eering design of deicing runoff manag NPDES Storm Water Permit Information 1 Does your site have an NPDES Storm Water permit for discharge of deicing runoff? 31 Are there known negative environmental consequences of deicing discharges? Current Type I Deicer Information (See MSDS and manufacturer's literature) EVALUATION WORKSHEET FOR ALTERNATIVE AIRCRAFT DEICERS 27 Do you periodically exceed your concentration limits for BOD5 or COD? cted deicer fluid (percent of applied glycol) 26 Have other water quality tools or models been applied to your site? 28 If so, what is the highest observed daily concentration? (mg/L) 10 96-hour aquatic toxicity (LC50) for fathead minnows (mg/L) 19 Do you collect deicing runoff for storage and treatment? 20 Collection technique 21 Estimated collection efficiency (percent of applied glycol) 22 Estimated losses of uncollected deicer fluid (percent of ap 101 ARW/EM 99 Glenn Ave Suite 494 Bangor IAP, ME 04401 Permit limits during periods of peak deicing activity 9 BOD5 concentration in the purchased product (mg/L) 30 If so, what is the highest observed daily load? (lbs/day) Do you exceed daily load limits for BOD5 or COD? 11 48-hour aquatic toxicity (LC50) for daphnia (mg/L) 12 Aquatic toxicity (LC50) for other organisms (mg/L)13 Name of other test organism BOD5 concentration of propylene glycol (mg/L) 23 Maximum daily amount accepted for treatment compliance or engin Lt Col D. Eric Johns, Environmental Manager regarding a switch to the new formulation. 8 Percent glycol in purchased product Deicer Collection and Storage Exceedances of Permit Limits Decay rate at 20°C (1/day) 2 NPDES permit number Other Known Problems Treatment Information **CURRENT SITUATION** 3 Permitting authority SITE INFORMATION KNOWN PROBLEMS Tools and Models 25 Unit cost 24 Units

Figure 3. Bangor ANG Evaluation

Other water quality models or tools may be available that provide a basis for more detailed evaluation

Other known environmental consequences of your deicing operations were indicated

No changes expected in volume of product purchased annually

Purchases of Product

Decrease of \$41,891 in annual costs

Other

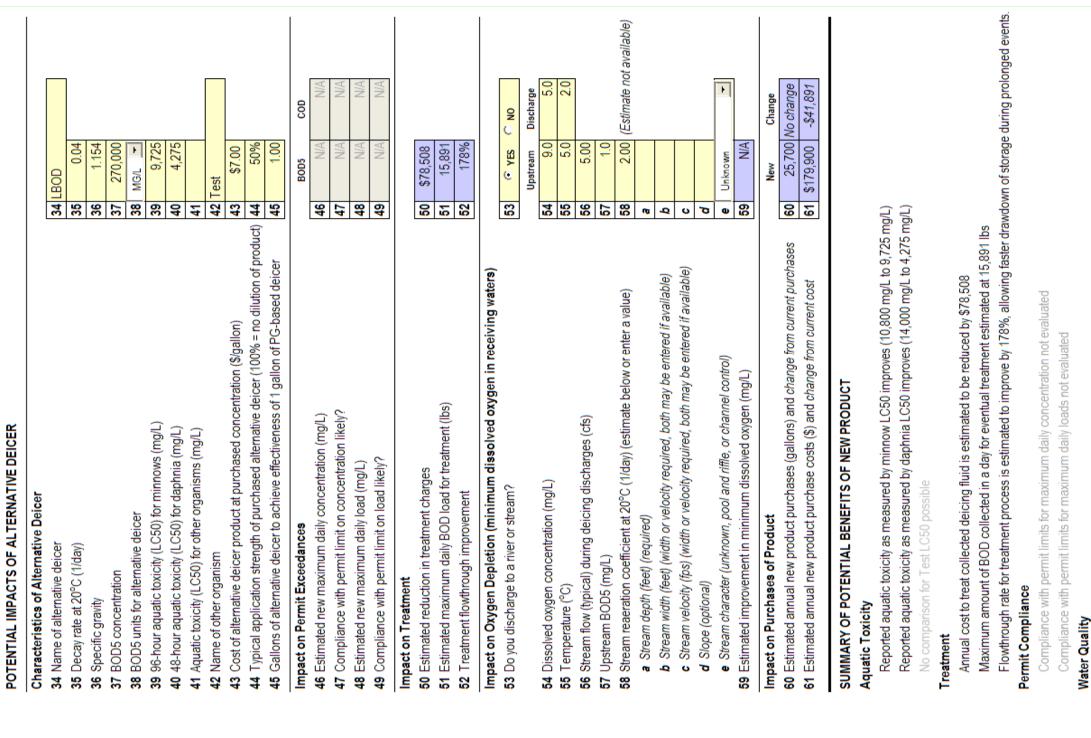


Figure 3. Bangor ANG Evaluation (continued)

cing runoff?  cing runoff management systems.  If there are no limits.  ature)  cing runoff management systems.  ature)  ature  ature)  cing runoff management systems.  ature  ature)  ature  ature)  ature  ature)  cing runoff management systems.  ature  atu	environmental, regulatory ative to the Type I ADF currently direction and magnitude of ded to support decisions  the required to support  Type I  O.18 650,000 88.00% 6572,000 10,800 14,000 14,000 51,000 50,700 50,700 50,000 50
compliance, and cost implications of a new Type IADE formulation that is being considered as an alternative to character and cost implications of a new Type IADE formulation that is being considered as an alternative to character and cost implications of a severed with a switch to the alternative ADE. This information is inferreded to severe death of the control o	ive to the Type I ADF currently rection and magnitude of ed to support decisions ed to support decisions  To reguired to support  To ref C No  To re
AFORMATION  For any benefits the ring a switch to the rential to understand strations of regular straining authority mitting authority mitting authority at stringent permit st stringent permit on thour aquatic toxic hour aquatic toxic hour aquatic toxic atic toxicity (LC50 me of other test on ual volume of app wimum daily volum ical application st of aircraft deicel collection technique mated collection	ed to support decisions ed to support decisions ed to support decisions ed to support decisions  To no 100 100 100 100 100 100 100 100 100 10
rential to understand that the tool is not intended to replace more sophisticated analyses that may strations of regulatory compilance or engineering design of delicing runoff management systems.  **PORMATION**  **Temporary Storm Water permit for discharge of delicing runoff?*  **Temporary Storm Water Permit Information**  **Storm Water Permit Informat	Number Number 100 100 100 100 100 10,800 14,000 14,000 50,600 16,800 16,800 17,000 18,000 18,000 19,
FERENDATION  In International Airport  All International Airport  Internation of regulatory compliance or engineering design of delicing runoff management systems.  International Airport  International Airp	Number 1000 Support 1000 1000 1000 1000 1000 1000 1000 10
Ferendational Airport  d International Airport  Air SITUATION  ENT SITUATION  Infiling authority  multimize during periods of peak deicing activity  at stringent permitted maximum daily load (lasiday). Leave blank if there are no limits.  Stringent permitted maximum daily load (lasiday). Leave blank if there are no limits.  Stringent permitted maximum daily load (lasiday). Leave blank if there are no limits.  Stringent permitted maximum daily load (lasiday). Leave blank if there are no limits.  To cent glycol in purchased product  Dis concentration in the purchased product (mgL)  Nour aquatic toxicity (LC50) for daphnia (mgL)  and volume of applied aircraft deicer mixture (gallons at working concentration)  and volume of applied aircraft deicer mixture (gallons at working concentration)  At of aircraft deicer at purchased deicer (100% = no dilution of purchased product)  Collection and storage  Nou collect deicing runoff for storage and treatment?  Air and collection and storage  Nou collect deicing runoff for storage and treatment?  Collection technique  Discontingent of purchased concentration (Sigallon)  Collection technique  Discontingent of purchased concentration (Sigallon)  Collection and storage  Nou collect deicing runoff for storage and treatment?  Air and a collection efficiency (percent of applied glycol)	000 000 000 000 000 000 000 000 000 00
fellense of themational Airport  Storm Water Permit Information  To Storm Water Permit Information  To Storm Water Permit Information  Storm Water Permit Information  To Storm Water Permit Information  To Storm Water Permit Information  To Information  Storm Water Permit Information  To Information  T	000 000 000 000 000 000 000 000 000 00
Telephor Telephor are no limits.	000 000 000 000 000 000 000 000 000 00
Telephon	000 000 000 000 000 000 000 000 000 00
Telephorus are no limits. 5   1   10   11   11   12   13   14   14   15   14   15   15   16   16   16   16   16   16	2000 000 000 000 000 000 000 000 000 00
are no limits. 4	005 1000 1000 1000 0,800 1,000 4,000 1,000 1,000
e are no limits. 4   2   3   3   4   5   5   5   5   5   5   5   5   5	00000000000000000000000000000000000000
e are no limits. 4   1   1   1   1   1   1   1   1   1	005 100 100 1000 0,000 0,800 1,000 4,000 4,000 1,000 1,000
e are no limits. 4   6   6   7   7   8   9   9   11   11   12   12   13   14   14   15   14   15   15   16   16   16   16   16   16	0055 1000 1000 0.18 0.18 0.000 0.800 4,000 4,000 4,000 1,000 1,000
e are no limits. 5	005 1000 1000 0.18 0.18 0.000 0.800 4,000 4,000 50% 50% 11,000
re no limits. 5    6     7     7       10	1000 0.18 0.18 50,000 10,800 14,000 14,000 50% 50%
6 8 9 9 10 11 11 11 11 12 13 Te was product) 16 17 18 18 18 19 19 19 19 19 19 19 19 19 19 19 19 19	0.18 0.18 50,000 10,800 14,000 20,700 50% 50%
6 8 9 9 10 11 11 11 12 12 13 Te purchased product) 16 17 17 18 18 18 19 19 19 19 19 19 19 19 19 19 19 19 19	0.18 50,000 10,800 14,000 14,000 50% 50%
8   9   10   11   11   12   13   Te   14   15   15   16   16   16   16   16   16	10,800 14,000 14,000 50,700 50%
10 11 11 12 13 Te nrking concentration) 15 fpurchased product) 16 17 17 18 18	72,000 10,800 14,000 20,700 50% 21,000
10 11 12 13 Te 16 16 17 18 18 18 19 19 10 10 10 11 11 11 12 13 14 17 17 18 18 18 18 18 18 18 18 18 18	10,800 14,000 20,700 50% 21,000
ncentration) 13 Te nrking concentration) 15 f purchased product) 16 n (gallons) 18 18 20 A	14,000 42,000 50% 50%
ncentration) 14 14 14 15 16 16 16 16 17 18 18 19 19 19 19 19 19 19 19 19 19 19 19 19	20,700 50% 21,000
ncentration) 14 nking concentration) 15 f purchased product) 16 n (gallons) 18 20 A 20 A	42,000 20,700 50% 21,000
f purchased product) 16 17 18 18 20 App	50%
17 18 18 20 A <sub>0</sub> 20 A <sub>0</sub>	21,000
19 © 20 Abron 21	\$0.63
19 © 20 Apron 21	00.00
20 Apron	YES C NO
21	on drainage diversion (20-50%)
22 Estimated losses of uncollected deicer fluid (percent of applied glycol)	30%
ation	, BOI
23 Maximum daily amount accepted for treatment 23 0.2 0.2 24 Unite	0.2 1200 × 1200 × 1200
25 0	0059 \$0.25
Aodels	
26 Have other water quality tools or models been applied to your site?	YES C NO
KNOWN PROBLEMS	
Exceedances of Permit Limits  27 Do you periodically exceed your concentration limits for BOD5 or COD?	ō
8005 28 If so, what is the highest observed daily concentration? (mg/L)  29 Do you exceed daily load limits for BOD5 or COD?  29 © YES	140 cob
800 (sq.)	009 COD
pleme	
31 Are there known negative environmental consequences of deicing discharges?  [31] © YES  [Description of the negative environmental consequence (optional)	

Figure 4. PDX Evaluation

3   Name of picture the electer   34   1800	leicer I/day)		
1164   36   1.154   37   270,000   38   MG/L   1.154   39   3.750,000   38   MG/L   1.154   40   4.275   41   4.275   41   4.275   41   4.275   42   1.00   44   2.75   42   1.00   44   2.75   42   1.00   44   2.75   42   1.00   44   2.75   42   1.00   42   2.75   43   2.75   44   2.75   2.75   45   2.75   2	l/day)		
1164   37   270,000   38   MG/L   1164   1			
37   270,000     38   MG/L   1     39   9,725     40   4,275     40   4,275     41   1     42   Test     42   Test     43   \$7.00     43   \$7.00     44   \$50%     45   \$1.00     45   \$1.00     45   \$1.00     46   \$50     47   \$1/16   \$1/16     48   \$2.16     49   \$1/16     40   \$1/10     40   \$1/10     40   \$1/10     41   \$1/10     42   \$1/10     43   \$7.00     44   \$1/10     45   \$1/10     46   \$1/10     47   \$1/16   \$1/10     48   \$1/10     49   \$1/10     40   \$1/10     40   \$1/10     41   \$1/10     42   \$1/10     42   \$1/10     43   \$1/10     44   \$1/10     45   \$1/10     46   \$1/10     47   \$1/16     48   \$1/10     49   \$1/10     40   \$1/10     40   \$1/10     40   \$1/10     40   \$1/10     41   \$1/10     42   \$1/10     43   \$1/10     44   \$1/10     45   \$1/10     46   \$1/10     47   \$1/16     48   \$1/10     49   \$1/10     40   \$1			
198   MG/L			
199   9.725   40   4.275   41   4.275   41   4.275   41   4.275   41   4.275   41   4.275   41   4.275   42   7   1.00   43   87.00   43   87.00   43   87.00   44   50%   45   7.00   44   50%   45   7.00   44   50%   45   7.00   48   2.16   4.0   2.10   49   1.00   40   40   40   40   40   40   40	ative deicer		
entration (\$lgallon) cleicer (100% = no dilution of product) cof 1 gallon of PG-based deicer cof 2 gallon cof 3 gallon of PG-based deicer cof 4 gallon cof 5 gallon cof 6 gallon cof 7 cof 6 cof			
41			
42   Test     43   \$7.00     44   \$5.00     45   \$1.00     45   \$1.00     46   \$5.00     47   \$1.00     48   \$2.16     49   \$1.00     40   \$1.00     40   \$1.00     41   \$1.00     42   \$1.00     43   \$7.00     44   \$1.00     45   \$1.00     46   \$1.00     48   \$2.16     49   \$1.00     40		-	
13   \$7.00			
Secondary   44   50%			
100    100			
1			
1	Impact on Permit Exceedances	8005	000
10   10   10   10   10   10   10   10			N/A
19			N/A
10   10   10   10   10   10   10   10			N/A
Solution	_		N/A
bs)  50 \$59,019  51 16,358  52 178%  52 178%  53 © YES  100  100  100  100  100  100  100  1	Impact on Treatment		
boxygen in receiving waters)  52 178%  52 178%  52 178%  53			
boxygen in receiving waters)  53		Ì	
boxygen in receiving waters)  53 © YES  Upstream  54 10.0  55 4.0  56 5.00  57 10.0  58 1.10  50 0.20			
ute below or enter a value)  may be entered if available)  th may be entered if available)  a 5.00  a 5.00  b 30.00  d 5.00  d	Impact on Oxygen Depletion (minimum dissolved oxygen in receiving waters)		
Upstream   10.0   54   10.0		© YES	ON
54   10.0     55   4.0     56   5.00     57   10.0     50   5.00     5		Ilnetream	Discharge
55   4.0		10.0	8.0
100   100	(0)		4.0
te below or enter a value)  may be entered if available)  th may be entered if available)  a 5.00  c 0.20  d 30.00  d 30.00  and change from current purchases  and change from current cost  b 0.20  c 0.20  d NIA  self \$147,000  New			
icient at 20°C (1/day) (estimate below or enter a value)  equired)  idth or velocity required, both may be entered if available)  width or velocity required, both may be entered if available)  width or velocity required, both may be entered if available)  known, pool and riffle, or channel control)  tin minimum dissolved oxygen (mg/L)  Product  The minimum dissolved oxygen (mg/L)  Product  AL BENEFITS OF NEW PRODUCT  AL BENEFITS OF NEW PRODUCT			
c   5.00   New   St   Channel control   St   St   St   St   St   St   St   S	icient at 20°C (1/day) (estimate below or enter a value)	1.10	Estimated = 0.52)
elocity required, both may be entered if available)  velocity required, both may be entered if available)  ool and riffle, or channel control)  num dissolved oxygen (mg/L)  nurchases (gallons) and change from current purchases  inchase costs (\$) and change from current cost  EFITS OF NEW PRODUCT			
velocity required, both may be entered if available)  ool and riffle, or channel control)  ool and riffle, or channel control)  num dissolved oxygen (mg/L)  num dissolved oxygen (mg/L)  New  New  New  New  EFITS OF NEW PRODUCT			
ool and riffle, or channel control)  num dissolved oxygen (mg/L)  num diss			
ool and riffle, or channel control)  num dissolved oxygen (mg/L)  New  Nurchases (gallons) and change from current purchases  EFITS OF NEW PRODUCT			
num dissolved oxygen (mg/L)  New  Nurchases (gallons) and change from current purchases  EFITS OF NEW PRODUCT	r (unknown, pool and riffle, or channel control)	L	
New New Nurchases (gallons) and change from current purchases  60 21,000 M  61 \$147,000  FITS OF NEW PRODUCT	Estimated improvement in minimum dissolved oxygen (mg/L)		
ual new product purchases (gallons) and change from current purchases  60 21,000 M  ual new product purchase costs (\$) and change from current cost  61 \$147,000  OTENTIAL BENEFITS OF NEW PRODUCT	Impact on Purchases of Product	New	Change
ual new product purchase costs (\$) and change from current cost  OTENTIAL BENEFITS OF NEW PRODUCT		21,000	o change
SUMMARY OF POTENTIAL BENEFITS OF NEW PRODUCT  Aquatic Toxicity			-\$34,230
Aquatic Toxicity	SUMMARY OF POTENTIAL BENEFITS OF NEW PRODUCT		
(	Aquatic Toxicity		
DANAGE SELECTION TO VIOLET OF MACCOLLEGE BY MINISTER CONTRACTOR CO	Unangle of the property of the		

Figure 4. PDX Evaluation (continued)

Flowthrough rate for treatment process is estimated to improve by 178%, allowing faster drawdown of storage during p Permit Compliance
The change in maximum daily concentration from 140 mg/L to an estimated 50 mg/L makes future compliance likely
The change in maximum daily load from BOD5 lb/day to an estimated 216 lb/day makes future compliance likely

Annual cost to treat collected deicing fluid is estimated to be reduced by \$59,019

Other known environmental consequences of your deicing operations were indicated
Other water quality models or tools may be available that provide a basis for more detailed evaluation

Purchases of Product
No changes expected in volume of product purchased annually
Decrease of \$34,230 in annual costs

Water Quality

POTENTIAL IMPACTS OF ALTERNATIVE DEICER